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New Marine Terminal at Los Angeles

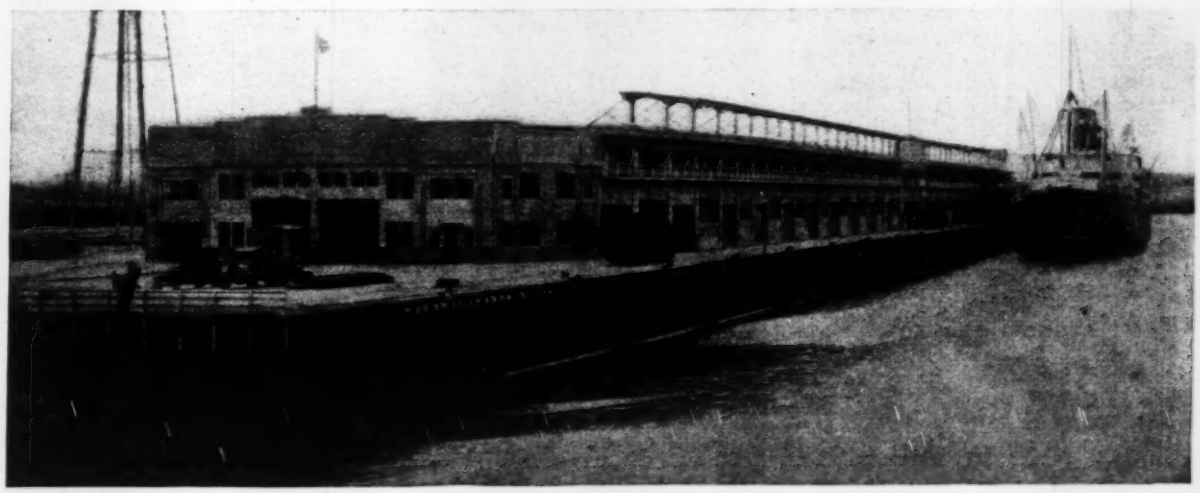
Design emphasizes convenience, comfort and safety for passenger traffic and facility in handling cargo—Asphalt-impregnated concrete substructure carries a steel-frame shed with concrete walls and timber roof

By G. F. Nicholson
Harbor Engineer, Port of Los Angeles
and E. C. Earle
Assistant Harbor Engineer, Port of Los Angeles

FEATURING facilities designed for the convenience and comfort of passenger traffic, a modern marine terminal has been completed at the Port of Los Angeles by the board of harbor commissioners. Located in the west basin of the inner harbor, the terminal includes a combination concrete and timber wharf 1,470 ft. long and a double transit shed 120x1,008 ft. Cargo-handling facilities include two wharf railroad tracks on the water side and three loading tracks on the land side, in addition to an adjacent open storage area served by a system of roadways. Architectural treatment of the exterior and interior of the transit shed provides a Spanish effect.

Fig. 1—Latest addition to terminal facilities at the Port of Los Angeles is a 1,470-ft. wharf carrying a 120x1,008-ft. transit shed of steel frame with concrete walls. Passenger corridor on top of shed permits passengers to bypass cargo-handling operation below.

Following the standard practice at the Port of Los Angeles, the 36-ft. width of wharf under the transit shed is a reinforced-concrete deck supported on asphalt-impregnated concrete piling. This practice is followed to assure maximum permanence for that part of the wharf structure that would be difficult and expensive of replacement. The method of impregnating concrete piling with asphalt was described in *Engineering News-Record*, July 18, 1929, p. 95. The under side of the reinforced-concrete wharf slab was sprayed with a



protective coating of emulsified asphalt. A bulkhead of impregnated 15x24-in. reinforced-concrete sheetpiling, stayed by substantial concrete anchors, retains the earthfill at the rear of the concrete wharf (Fig. 2). The 31-ft. apron wharf fronting the concrete section was constructed of creosoted timber and piling to lend resiliency to the structure and assist the fender system in absorbing the impact of berthing vessels.

Substructure design was based on results of a thorough exploration and study of the underlying material of the harbor bottom, and on the results of driving test piles at intervals over the area of the wharf site. A 2-in. core drill was used to make borings. Materials encountered varied from soils possessing reasonably good friction factors at the north end to thin layers of soft clay underlain by a soft silt of great depth at the south end, the latter condition requiring unusually long piles to obtain bearing (Fig. 3).

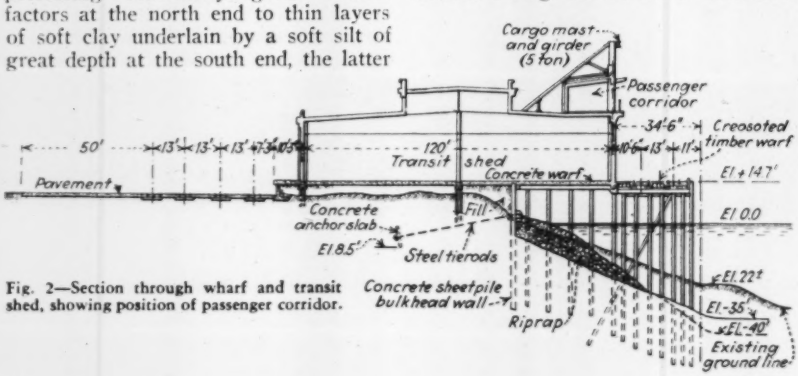


Fig. 2—Section through wharf and transit shed, showing position of passenger corridor.

Bents are spaced 10½ ft. on centers with sufficient piles in bents to support the design loads. In general, concrete bearing piles were designed and driven to carry 30 tons and timber piles 20 tons. A live load of 500 lb. per sq.ft. was assumed over the entire area except the tracks where an E-40 locomotive loading was used, following the standard practice of this port.

The wharf was paved with sheet asphalt, flush with tops of rails. The transit shed floor over the earthfill area consists of a 6-in. concrete slab resting directly upon the fill, surfaced with a specially proportioned asphaltic concrete, metallic in effect, found to be resistant to wear under abrasive action of heavily loaded and fast-moving steel truck wheels and, at the same time, non-plastic under heavy static loads in the storage zones.

Steel and concrete transit shed

The 120x1,008-ft. transit shed has a single row of interior steel columns, at 42-ft. spacing, supporting steel roof trusses (Fig. 4). Walls are of reinforced concrete, and the roof is of combination felt and gravel type on timber purlins and sheathing. Inexpensive, but effective architectural treatment is provided on the exterior by a finish in old Spanish motif. Interior walls of offices and passenger accommodations are plastered with modified Spanish effect above a travertine wainscoting, with floors in dull red tile marked off by ground joints in an attractive design.

The shed is well lighted by continuous steel sash running the entire length of the roof monitor and by fixed steel sash in every alternate panel of both walls. Manually operated rolling steel doors, 17 ft. wide by 14 ft. and 10 ft. high on the water and land sides, respectively, are provided in the shed walls, alternating with the steel sash. Main traffic doors at the ends of shed and at the central entrances on the land side are 16 and 22 ft. wide, respectively.

Artificial illumination for operation of the wharf at night has been provided by standard lighting units distributed to produce uniform intensity of about 2-ft. candles throughout the shed. The shed is power-wired for the convenience of operators and stevedoring firms requiring electrically operated equipment. In addition to overhead angle reflectors outside the shed walls, outlet plugs have been provided at each rear door for the use of cargo checkers at night, and along the rear loading platform to permit the use of extension cords and lights for use in loading cars.

The entire structure has been equipped with an automatic sprinkler system conforming to underwriters' requirements, using the Los Angeles municipal water supply supplemented by an auxiliary 100,000-gal. steel tank on a 100-ft. tower.

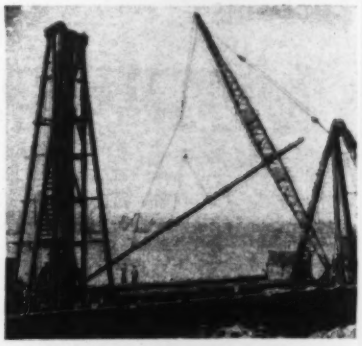


Fig. 3—Long concrete bearing pile for wharf foundation being picked up by 6-point equalizer.

Fig. 4—Transit shed has one row of columns on 42-ft. spacing, abundant windows and complete artificial lighting for night work.

Fig. 5—Detail of landing stage, motor-controlled and counterweighted, leading from passenger corridor and balcony.

A heavy-duty cargo mast has been constructed the full length of the transit shed for use in conjunction with ship's whips in handling cargo, especially long lengths of pipe and steel, from ship's holds to railroads cars located on ship-side wharf tracks.

A loading platform 10 ft. wide is provided at floor level along the land side of the transit shed. There are three lines of low-line railroad loading tracks served by a running track, fully paved with asphaltic concrete, at the rear of and at an elevation of 3 ft. 10 in. below the loading platform to facilitate cargo movements between shed, trucks and freight cars. The platform and tracks have been laid out on a saw-tooth arrangement, following a plan of the Port of Los Angeles, making possible the movement of railroad cars without interference with loading operations of trucks or railroad cars at the adjacent shed. A wide concrete roadway has been provided back of the low-line tracks to facilitate trucking.

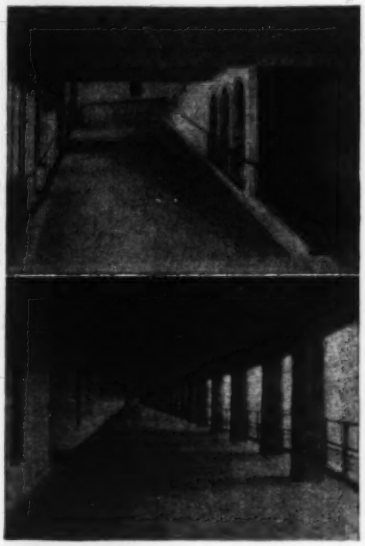


Fig. 6—Broad ramps (top) lead from waiting rooms to an outside corridor running the full length of the shed (bottom) for the convenience of passengers and visitors. Danger from and interference with cargo-loading operations are completely eliminated.

Passenger facilities

The usual exposure of passengers to risks encountered in passing through the relatively dangerous and noisy areas utilized for trucking, storage and handling of cargo has been completely avoided at this terminal by the construction of an overhead passenger corridor 18 ft. wide (Fig. 6, bottom) along the ship side of the wharf, supplemented by a specially designed motor-operated passenger landing stage and gangplank. Due to the equable climate in Southern California the water side of the corridor has been left open between columns and is provided with a continuous balcony overlooking the wharf deck below. The balcony has a substantial wrought-iron pipe railing with woven wire panel inserts. From this corridor visitors can exchange greetings with passengers upon arrival and departure of ships, and can observe cargo-handling operations on the deck below without danger to themselves or interference with other activity. The hand-railing has removable sections to permit making gangplank connections between the passenger ports of different vessels and the corridor.

Access to the corridor is provided by wide easy ramps of fireproof construction (Fig. 6, top) leading from attractively finished waiting rooms on the land side of the shed at either end of the terminal, where passengers and visitors arriving by automobile or train will find every modern convenience, with plenty of parking facilities in the immediate vicinity. Ample baggage-inspection accommodations are provided in the shed adjacent to the waiting rooms.

Offices for the use of shed assignees have been constructed on the second floor above the waiting rooms, and additional two-story office accommodations have been provided on the water side at either end of the shed for the use of wharf operators. The second-floor offices are connected by a concrete balcony across the shed at either end, and the water-side office opens directly into the passenger corridor, thereby providing direct access to the corridor from both offices.

With a view to providing ample temporary open-storage areas for the extensive movements of steel and iron products arriving from Atlantic and Gulf ports, an area of about 12 acres has been laid out at the rear of the terminal in diagonal parallel zones, 400 ft. long and 80 ft. wide, served by six concrete roadways. This width of storage areas was selected as best adapted for unloading steel products by truck-mounted cranes from low trailers drawn by wharf tractors, and subsequently reloading upon trucks and trailers which transport practically all steel pipe, structural steel, and similar freight from the harbor district on hauls too short to warrant rail shipment.

The terminal was designed and constructed for the Los Angeles board of harbor commissioners under the general supervision of the writers and the engineering staff. The cost of the completed wharf, tracks, roadway and storage areas will be about $1,250,000.

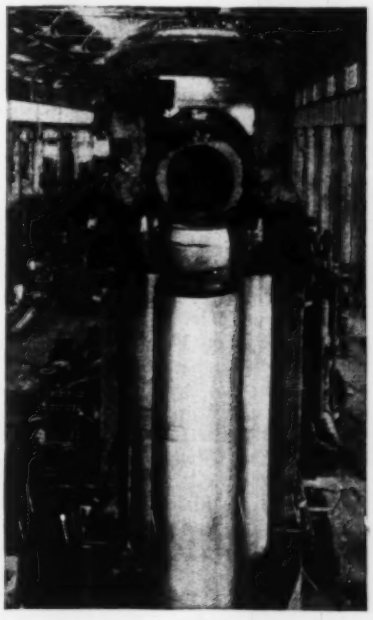
The major units were constructed under contract by the Pan-Pacific Piling and Construction Co., the Merritt-Chapman & Scott Corp., the McClintic-Marshall Corp., and the Stanton-Reed Co., all of Los Angeles.

Huge Bending Roll Shipped to Hoover Dam

EQUIPMENT for the steel-fabricating plant to be located at the end of the government railroad on the canyon rim above Hoover Dam must be capable of changing 50,000 tons of flat steel plate into penstocks and outlet pipes of 8¼, 13, 25 and 30 ft. in diameter (*ENR*, July 21, 1932, p. 79). The largest of the items of equipment is a powerful bending roll to shape the plates, which range in thickness from ⅞ to 2⅞ in. This roll, weighing about 250 tons, was shipped by water from the plant of the manufacturer, Baldwin-Southwark Corp. in Philadelphia, to San Pedro, Calif. From there it will go by rail to the fabricating plant of the contractor, Babcock & Wilcox Co., at Hoover Dam. The roll was designed and built specifically for the Hoover Dam job. It is one of the most powerful vertical bending rolls ever constructed and is unique in that it will be used not in a fabricating plant a thousand miles from the job, but actually on the site like any other piece of field equipment.

In designing the bending roll the requirements for the 30-ft.-diameter penstocks (made of 2⅞-in. plate) were controlling. These pipes, being about 94 ft. in circumference, had to be fabricated from three 31½-ft. long plates; and since the maximum size plate that can be manufactured and transported is of about this length and about 12 ft. wide, the penstock was designed as a series of

Fig. 1—Upper end of bending roll, showing how housing may be lifted to permit removal of plates rolled to a complete circle.



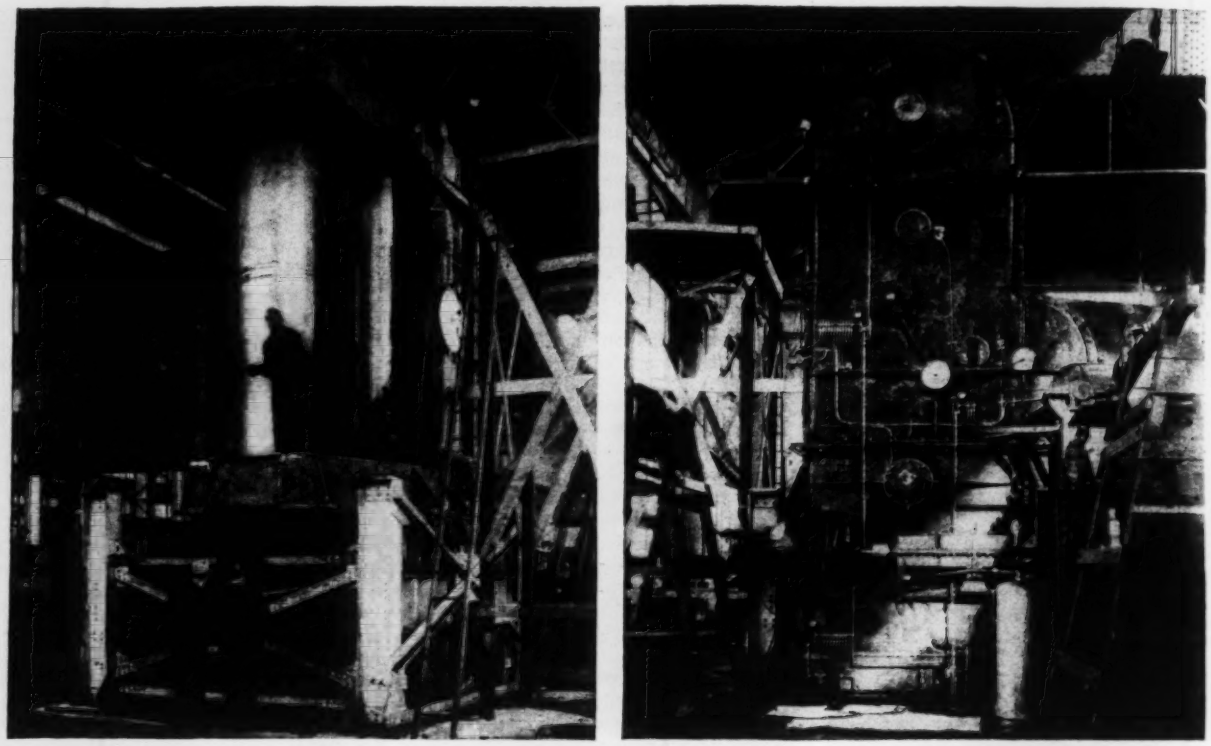


Fig. 2—The bending roll for the penstock and pipe-fabricating plant at Hoover Dam, undergoing test in Philadelphia. Views show a front and rear elevation. In the left view the workmen are standing at what will be the floor level in the plant. Above the top of the 3-in. plate that is being rolled may be seen a portion of the special crimping die, used to bend the ends of the heavy plates.

12-ft. rings. This 12-ft. dimension fixed the length of the bending roll, and the 2⅞-in. thickness largely determined its power requirements. Since each plate weighs about 25 tons, a vertical-type roll was the most economical to build and the most practical to operate, for, with the axes of the rolls vertical, the weight of the plate is not carried by the machine but is supported directly by the foundations. Handling the plate into and out of the rolls is also facilitated by the vertical design, since it can more easily be moved on edge than when lying flat.

As shown in the accompanying illustrations, there are three rolls, an outer one operated solely by the friction of the plate in passing through, and a set of two inner rolls driven by a 150-hp. motor. The outer roll is 40 in. in diameter for 12½ ft. of its length and has journals on either end 22 in. in diameter by 24 in. long. Bearings are of special bronze and are pressure-grease lubricated. This roll, with the top bearing and bearing shell, weighs about 65,000 lb. and is mounted on a roller thrust bearing to render it as near frictionless as possible. Its speed of operation will be about 1 revolution per minute. The two inner rolls are 32 in. in diameter for 12½ ft. of their length and have journals 16 in. diameter by 22 in. long. The drive for these rolls gives a plate speed through the machine of 10 ft. per minute. The largest gear in the drive mechanism has a face 24 in. deep. Inasmuch as most of the driving machinery will be below the floor at the fabricating plant, provision is made for the entire gear box to be lowered a few inches to rails set in the foundation and then moved laterally from under the machine, thus facilitating inspection.

In addition to the rolls, the machine includes a special screwdown mechanism made up of a 100-hp. motor, gearing, large nuts and screws whose function is to bend the plate initially before the rolling operation is started. Then after one or two passes of the plate through the rolls this screwdown is operated to draw the outer roll closer to the two inner rolls and thus progressively to decrease the radius of the rolled plate to that required. The machine is designed to have a screwdown load of 1,500,000 lb. during the rolling operation.

On such heavy plates as will be required at Hoover Dam it is impossible to secure a true radius near the ends of the plate by the normal rolling operation. Consequently it was necessary for this purpose to provide a special crimping die, which has a much shorter span than that provided by the inner rolls. When crimping, the screwdown design load is 3,300,000 lb. During tests at the shop a load of 5,700,000 lb. was recorded for this operation.

Unlike the heavy plates that are not rolled to a complete circle some of the smaller plates will require complete circular shells and therefore must be removed over the end of the outer roll. To permit this operation, the upper structure is designed to be turned upward and backward (Fig. 1). This movement of the upper yoke is effected by a hydraulic cylinder operated by a motor-driven rotary pump. Provision is also made for the rolling of conical shells by adjusting the outer roll out of parallel with the inner rolls.

Numerous safeguards are provided to prevent injury to this machinery during operation. Two limit switches on the screwdown mechanism prevent injury to the equipment by overrun. There is also a manually adjustable intermediate limit switch that the operator can adjust for a given radius of rolling. Limit switches also are provided for handling the upper yoke. Lubrication, except for some pressure-greased bearings, is by oil flood from rotary motor-driven pumps. The controls to these pumps are so interlocked with the main motors that the latter cannot be started until the lubricating oil pumps are in operation. The screwdown motor control is such that if the motor is overloaded and stalled when crimping, the reversing of the motor puts an additional torque on the screwdown system to break the friction. If this were not provided, the screwdown system, if stalled, could not be moved in either direction.

In the fabricating plant at Hoover Dam this large bending roll will be supplemented by other special equipment required in the interesting operations of welding the rolled plates into pipe and of examining every inch of weld metal by X-ray.

Federal Engineering—Article II

Airway Engineering in the Federal Government

Route surveys, intermediate landing fields and beacon towers are the principal civil engineering items that are handled by the Aeronautics Branch of the Department of Commerce in establishing and maintaining our 20,000-mile system of airways

SEVERAL specialized branches of the engineering profession contribute to the work of establishing and maintaining the federal airways system, a project of the United States government that is handled by the Aeronautics Branch of the Department of Commerce. Civil engineers, electrical and lighting engineers and radio engineers have specific tasks to perform. All of these specialists must also have an intimate knowledge of the needs of aeronautics with respect to aids to air navigation.

Airways established by the Department of Commerce now comprise a system 19,500 miles in length equipped with the following aids to air navigation: beacon lights; lighted intermediate landing fields; airway radio stations for the broadcast of weather information to aircraft in flight; radio range beacons for the transmission of radio beams that aircraft may follow and so keep on course regardless of conditions of visibility; marker beacons, low-powered transmitters that mark important intermediate landing fields; and a nation-wide system of teletypewriter circuits for the collection and dissemination of weather information to airports and airway radio stations.

Preliminary aerial survey

The first step taken by the Aeronautics Branch in its work of building an airway is to conduct a preliminary aerial survey of the proposed route. The major purpose of this aerial survey, which is made by an airway extension superintendent, is to examine the route as to general type of terrain, possible sites for intermediate landing fields, existence of power lines that will be needed to provide current for the lights, and the location of roads, centers of habitation and all natural aids or hazards to flying and to the construction and maintenance of the airway. The superintendent also gathers any other information that may assist him in making a preliminary layout.

During the first flight he generally does not attempt to locate specific sites for landing fields and beacons, but instead makes a general appraisal of a strip about 25 miles wide over the proposed route. On subsequent flights he gives closer attention to the details and particularly to possible sites for intermediate landing fields which, in combination with municipal, commercial, and private airports that may already be in existence, will provide landing facilities at intervals of 40 to 50 miles. An attempt is made to locate sites for intermediate landing fields in as near a straight line between terminal points as possible, but in some types of terrain this is not practicable, and routes alternate to the straight line may be surveyed in order to find one that is suitable.

When the aerial survey is complete, a report is submitted to the Aeronautics Branch for review. This report contains a map showing the tentative locations of the fields and the number of beacons that will be needed to furnish lighting at 10- to 15-mile intervals along the airway. The locations of the beacons are fixed largely by the positions of the intermediate landing-field sites.

Fig. 1—Activity incident to the construction of an airway beacon on Newman's Peak, Ariz. At the top a civil engineer of the Aeronautics Branch encounters rough going on the reconnaissance survey. Left: burro packing part of an airway beacon to the site. Right: with the beacon tower erected in a crater blasted out of the summit of Newman's Peak, electricians are installing the cable for the 2,000,000-cp. beacon light.

Ground survey

If the route is approved as submitted, a ground survey is then ordered to determine specific locations of fields and beacon lights and to negotiate leases for the sites. This survey is made by the airway extension superintendent aided by a Department of Commerce civil engineer. The engineer examines each field site carefully to determine the amount of conditioning work necessary and the probable cost of the work. Traverses of the various tracts are run, and notes and sketches are taken of the surrounding topography. Studies also are made of the type of soil and the drainage situation. At this time also a complete topographic survey of the proposed field may be made in order to obtain the data necessary for the preparation of proposals and specifications under which the conditioning work will be performed.

In some cases where alternate tracts may be under consideration in the same locality, the engineer makes comparative estimates of the probable cost of the preparation of each site, and additional information is accumulated to aid in selecting the more suitable location.

Fewer problems are involved in selecting sites for beacon lights. The main consideration is to find a site, usually a high point, where the light will not be obstructed from the view of airmen by trees or higher ground elevations.

Negotiations with property owners for leases of the desired property come next. These leases are valid only for the fiscal year for which they are negotiated, but they include a provision for renewal at the government's option from year to year for a stated period, usually ten years or more. With this work, preliminary operations are completed, and an engineering report is submitted to the Aeronautics Branch. This report contains a general map of the airway, showing the locations of the various beacon and field sites and a detailed sketch map of each site. The sketch maps show such items as the types of obstructions near the sites, the locations of roads, bodies of water and communities, the types of beacons or fields needed, the owners of property and any other necessary information. The leases are also forwarded as a part of the report.

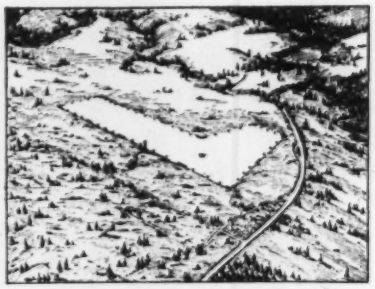


Fig. 2—A completed intermediate landing field. These fields are spaced at about 50-mile intervals between regular airports. Landing surfaces on these fields are graded and obstructions are removed. Each field is supplied with a beacon, illuminated wind indicator, course lights, boundary lights, etc.

Fig. 3—Latest type of 36-in. double-ended airway rotating beacon. The two lights on the top platform are course lights, one pointing in each direction. These lights show green at sites where there are landing facilities and red at sites that are not so equipped. Each course light also, by means of flashes, indicates the code signal of the beacon.

Points where radio range beacons for giving directional service and airway radio-communication stations, for broadcasting weather information or emergency messages, will be established (usually at intervals of 200 to 250 miles) are chosen when the general locations of intermediate fields are definitely known. On the other hand, in some cases locations may be recommended at the time the preliminary survey report is submitted, or it may be that such stations are already in operation along a course that is being used as a day route or for the purpose of furnishing information for other airways adjacent to or intersecting the route being surveyed.

When the engineering report is received by the Aeronautics Branch, a careful study is made of the cost of conditioning the field sites and of establishing beacons, of the suitability of the radio range beacon and radio weather-communication station locations, and of the cost of the property leases. If the survey proves satisfactory, its approval is signified and authorization for the necessary construction work is given. When this approval is received and the leases between the Department of Commerce and the property owners are executed, contract proposals and specifications covering the conditioning work considered necessary to place the intermediate landing fields in proper shape are prepared by the engineer who made the survey. The contracts for establishing the beacon lights and landing-field lights are handled as a unit for the entire airway or for sections of 200 to 300 miles by the construction section of the Airways Division in Washington.

Constructing the intermediate fields

The contracts for conditioning intermediate landing fields are supervised by the engineer who advertises for bids and awards contracts. In addition to removing obstructions and grading, it is sometimes necessary to provide subsurface drainage systems. Also, in some cases diversion ditches or small levees must be built. Where obstructions such as buildings, wires or trees cannot be removed, they are later marked by obstruction lights when the lighting system is installed.

During the latter stages of the conditioning work a location is selected for the watchhouse to be used by the airways keepers who will be in charge of the field, but the house generally is not constructed until the field has been fully conditioned and lighted. The building is erected by carpenters hired locally, working under the supervision of a Department of Commerce engineer or contractor.

The material necessary for the installation of beacons, with the exception of miscellaneous items of hardware that the contractor provides, is furnished by the Department of Commerce. This material includes the beacons themselves, wind indicators, engine generators, fuel-storage tanks where required, course lights, switch cabinets and automatic control switches. The contractor is required to clear away all trees, brush, rocks and other material necessary to provide a clear space for the beacon tower and power shed. After the beacon light has been erected, other work such as the placing of concrete for the power-shed foundation, building the power shed, installing the engine generators and fuel-storage tanks, laying of cable and installing metal directional arrows is performed.

The intermediate landing fields are marked and lighted for identification from the air both day and night. The marking consists of a white circle 50 ft. in diameter at the intersection of the runway center lines, with white panels 40 ft. long and 4 ft. wide extending from the outside of the circle along the runway center line, to indicate the landing directions. The boundaries are marked by metal cones painted orange and installed below the boundary lights, and by fence-type markers in 70-ft. sections installed at angles and along straight sides.

The standard lighting installation for an intermediate field is comprised of a beacon, course lights, boundary lights, range lights, obstruction lights and illuminated wind indicator. A standard 24- or 36-in. rotating beacon of the same type as those situated at 10- to 15-mile intervals along the airway is provided at each field except at fields that lie off the straight course marked by beacons, or in valleys at irregular intervals between beacon sites, when electric-code beacons of lower candlepower may be provided.

At the time the lighting contract is advertised, or shortly thereafter, contracts are negotiated with power companies having lines in the vicinity of the

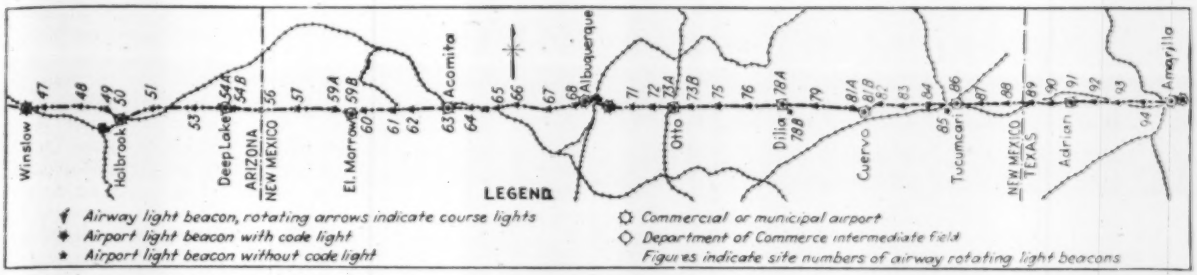


Fig. 4—Typical section of Los Angeles-Amarillo airway with lights, airports and landing fields marked.

intermediate fields and beacon-light sites. The agreement includes erection of any pole lines and installation of the wiring necessary to provide current at the sites. In cases where the distance a power line must be extended to reach a field or beacon site is so great as to make the cost of extension prohibitive, local generators are installed. Two generators are supplied for each such field, one being stand-by equipment. The engines for these generators are fed from fuel, stored in two 515-gal. tanks, containing sufficient fuel for three to five months' operation. At sites that are difficult to reach because of weather or bad roads, four tanks may be installed that hold enough fuel for eight to ten months of operation.

During the construction period an inspector of airway construction maintains constant supervision over the lighting installation work as it progresses, seeing that the work proceeds normally and strictly according to specifications.

After the establishment of lights has been completed, an inspection is made. If everything is found to be satisfactory, the airway is accepted by the Department of Commerce and the lights are turned on.

Special beacon and radio stations

The establishment of other aids to air navigation, such as weather-reporting service, radio-communication stations, radio-range beacons and intermediate airway stations, all needed to complete the air-navigation aids that will constitute an airway, is in most cases carried out independently of the installation of the lights. An attempt is made in all cases, however, to have them ready for operation by the time the beacon lights are turned on.

The specific locations of sites for the radio-range beacons and airway-communication stations are chosen by an airway radio engineer. The engineer, after he has located specific sites that will be satisfactory, then negotiates leases for property, which are made on the same basis as those for intermediate landing fields and beacon sites.

Construction of radio-range beacons and communication stations may be under way at the same time the lighting work is in progress. The buildings that house the equipment are usually constructed by workmen hired locally. All the transmitting equipment for each range beacon and communication station is furnished by the Department of Commerce and installed by an airway radio electrician assisted by electricians hired locally.

When the major portion of the airway aids have been installed and placed in operation, the airway is assigned to the airway maintenance districts of the Department of Commerce, which are responsible for the operation and maintenance of the facilities.

Airway construction and maintenance, although one of the most important functions of the Aeronautics Branch, is not the only one for, in addition to the Airways Division, there is the work of the Air Regulation Service and the Aeronautic Development Service.

Responsibilities assigned to the Air Regulation Service include licensing of aircraft and airmen, inspection of interstate air passenger services, approval of flying schools and aircraft repair stations, and inspection of parachutes. Aircraft licening involves a number of special functions in connection with approval of the design of aircraft, of aircraft engines, of components and accessories, and of facilities of factories producing aircraft. The Air Regulations Service also enforces the air commerce regulations and air traffic rules and conducts investigations of aircraft accidents.

The general promotional program of the Aeronautics Branch is carried out by the Aeronautic Development Service. This includes dissemination of information on aeronautics, pursuing of research work designed to increase the safety and reliability of air transportation, fostering of airport development and compilation of airway bulletins and maps for use in air navigation.

* * *

THE AIRWAYS DIVISION of the Aeronautics Branch, organized within the Bureau of Lighthouses, of the Department of Commerce, now has had six years of experience in constructing and maintaining airways. Improvements in equipment have greatly enhanced the value of these aids to airmen, and increasing knowledge of the technique involved in their use also has contributed to their utility. At the close of the fiscal year 1932 there were in operation and under construction or installation 19,500 miles of lighted airways, 69 radio-communication stations, 94 radio-range beacons, 118 radio-marker beacons, and 233 teletypewriter stations on a leased-wire system comprising some 13,000 miles of circuits.

No extension of the airways system will be undertaken during the current fiscal year. Maintenance and operation is carried on through regular district organizations of the Lighthouse Service. To serve the airways between the Mississippi-Missouri River Valley and Pacific Coast states, where the Lighthouse Service has no district organizations, airway maintenance organizations have been established at Salt Lake City and Fort Worth.

The technical staff of the Airways Division includes 35 airway engineers, twelve radio engineers, fourteen civil engineers, sixteen communications supervisors, six airway extension superintendents and twelve inspectors of airway construction. The total force of 2,047 includes a large number of clerks, radio operators, mechanicians, keepers and part-time caretakers. The gross appropriation for the current fiscal year amounts to $7,553,500, of which $6,446,250 is required for airway maintenance and operation. Other allotments include $95,000 for research and experimentation in cooperation with the Bureau of Standards, $65,000 for airway mapping in cooperation with the Coast & Geodetic Survey, and $55,000 for consultation on construction and rating of municipal and privately owned airports.

The engineering executive staff of the Airways Division includes F. C. Hingsburg, chief engineer; C. I. Stanton, assistant to the chief engineer; W. T. Miller, airways superintendent; A. J. LaBaie, construction section; and H. J. Walls, radio section.

Another article in this series on federal government engineering will be published in the near future.

City Cars Predominate on Indiana Roads

More than 69 per cent of all traffic on Indiana state highways is made up of city-owned vehicles and 15 per cent of farm-owned, while the remainder is contributed by people living in the 92 towns and villages of less than 2,500 population, according to a traffic census last season by the state highway department. The survey shows 15.5 per cent commercial vehicles (trucks or buses). On county roads the city-owned vehicles were 61.5 per cent, farm-owned 23.3 per cent, and town- and village-owned 15.2 per cent. Registration shows percentages of 54.3, 26.6 and 19.1 per cent for the three respective classes. Two-thirds of all rural traffic is concentrated on one-eighth of all the roads of the state. These figures were given by Ralph E. Simpson, assistant director of the department, at a recent meeting of the Indiana Highway Construction Association.

Western Irrigation District Successfully Refinanced

Special problems solved in effecting first major refunding program for a California district—All but 2 per cent of bondholders accept new 4 per cent bonds in place of 5½ per cent originals—Procedure sets precedent for future refinancing

By William Durbrow
Manager, Nevada Irrigation District

AS THE forerunner of further irrigation district refinancing in California and other states, the pioneering of the Nevada Irrigation District (Calif.) in its large-scale refunding program is a development of unusual importance. Already three more major refinancing plans, involving more than $20,000,000, are nearing completion in the state. The present case is in some respects specialized by reason of its large power revenue, but regardless of the individual features of each case there are fundamental problems common to all. These include the financial impasse under existing financing, the campaign of education required to effect the necessary compromise, legal hurdles, and the actual details of the refunding. The author speaks with authority not only because as manager of the Nevada District he was in active charge of the refinancing described, but also because he is president of the organization of irrigation districts in California and therefore is familiar with the broad aspects of the general problem.
—EDITOR.

WITH the voluntary agreement of 98 per cent of the bondholders to accept 4 per cent refunding bonds in place of the original 5½ per cent issue, the Nevada Irrigation District refunded its $8,100,000 debt in the first major refinancing program consummated by a California irrigation district. The rate reduction permits carrying the interest charge and retiring an amount estimated at more than half the principal by 1977 from the power revenues available under existing contracts. Assessments against lands in the district will continue to cover operation and maintenance of the distribution system. Because of lack of precedent as to refinancing of irrigation districts, much pioneer work had to be done in arranging the agreement. This work included securing legislative action to legalize sinking-fund bonds for refunding issues of irrigation districts, and a state supreme court ruling. Discouraged debtors and 3,500 creditors scattered all over the country had to be educated to a full recognition of the problem and brought together on a compromise for the best mutual benefit.

Pyramiding financial difficulties in the district reached the point of default of interest payment in July, 1931. A deficit of about $140,000 was occasioned by an extreme low-water year, which decreased the power revenue essential to the financial set-up of the district. A bondholders' committee was formed. The problem was attacked from the approach of practical economics to determine the relation between revenues and expenses, and the ability of the district to carry the load. An independent engineering and economic study indicated that additional assessments on the land to make up deficiency in power revenue would result in heavy delinquencies and ultimate failure. The only alternative was to reduce fixed charges. This was accomplished by reducing the interest rate to a point where the bonded debt could be carried by conservatively estimated power revenues. A special provision in the new bonds makes some additional revenues available to increase the interest rate to 5½ per cent when and as earned. This articles outlines briefly the physical and financial features of the district and then describes the refinancing program.

History and physical features

The Nevada Irrigation District includes about 268,000 acres of rolling foothill land in Nevada and Placer counties adapted to deciduous orchards, general crops and dairying. District organization was effected in 1921 by local farming interests to insure the perfecting of water rights for the local area before power rights would become established. From its inception the plan of development provided for selling falling water, between the district's main storage and distribution system, to a private utility; the power revenues were sufficient to deliver the water free at the head of the distribution system. Several years were required to perfect governmental requirements and negotiate the details of the power contract with the Pacific Gas and Electric Co. A bond issue of $6,000,000 was voted in July, 1925, to cover the original construction program established by F. H. Tibbetts, chief engineer of the district.

Water is derived from a catchment area comprising 71 square miles on the headwaters of the Yuba River, and is impounded in a 67,000-acre-ft. reservoir by a 170-ft. rockfill dam. Smaller reservoirs bring the total storage capacity to approximately 85,000 acre-ft., and a 4½-mile tunnel diverts a supplemental supply from the middle fork of the Yuba River into the main storage reservoir. The reservoir discharges into a 10-mile conduit of 250-sec.-ft. capacity (2½ miles of metal flume, 6 miles of open ditch and the remainder tunnels and siphons), delivering water at a point 315 ft. above the Lake Spaulding reservoir of the Pacific Gas and Electric Co., where a power plant was built to use this new supply. In addition, the power company uses the district's water through lower existing power plants and finally re-delivers it to the district at various points on the distribution system. Designed to cover an area of about 100,000 acres, the system required expensive construction because the majority of the irrigable area is located on ridges and hilltops, requiring long lengths of ditch and flume.

The original plan classed 126,000 acres of the area as irrigable. At the time of the district's formation about 3,000 acres of land was already under irrigation from a partial supply. At the present time the irrigated land in the district totals about 9,000 acres; about 4,000 acres is served by works other than those of the district. A gradual extension of distribution canals is being made as required.

Financial and Power Set-up — The financial feasibility of the district was based on power revenue sufficient to repay costs of the mountain system and deliver water free into the distribution system. Extended negotiations resulted in securing a 50-year contract (1927-1977) with the Pacific Gas and Electric Co. for the sale of the stored water. The details of the power contract and the district company set-up are complicated and are of no particular interest. In general, however, the contract provides that the district is to deliver 108,000 acre-ft. of water from its mountain system for nine months of the year, beginning in July. The revenue based on full delivery was estimated to be $438,000 annually for the first 25 years of the contract (1927-52); for the second half of the 50-year contract a reduction in rate cuts the revenue to an estimated $240,000 per year. These revenue figures, of course, are based on the ability of the district to deliver the specified quantity of water, which a careful study of past runoff records indicates it will be able to do in a high percentage of years.

Financial problems

Prior to actual completion of the district and the beginning of operations, financial difficulties became evident, which can be attributed to the following principal causes: (1) delay in the construction program, increasing interest and reducing the income from the estimated sale of water for the first year; (2) expenditures of $2,450,000 in excess of the original cost estimate to cover increased interest charges during construction and for distribution works in areas not included in the original district plan; (3) low-water year in 1928-1929 and record-breaking drought in 1930-1931, resulting in seriously decreased power income; (4) slow development of irrigated areas within the district, resulting in deficit in operating

income; (5) final aggregate indebtedness of $8,100,000, which, based on the 5½ per cent interest charge, required a $445,000 interest payment and serial payments on principal beginning in 1933. Such interest charges alone were $7,000 in excess of the maximum power revenue.

Among this group of causes one of the most serious was the marked low flow for two seasons, which established a deficit in power revenue that presented an almost impossible financial hurdle. Further, the construction period was extended beyond the original estimate, resulting in contractors' claims for extra work to the amount of about $800,000, which was temporarily met by issuance of warrants. Overenthusiasm on the part of land-owners within the district resulted in expanding the distribution system to include areas that were infeasible. Overoptimism also inflated the original estimates of power revenue beyond reason. Coupled with these problems came the continued decline in agricultural prices, making it financially impossible for irrigators to pay any deficiency assessment.

During the two-year period prior to default in July, 1931, while the writer was in charge of the management of the district, rigid economies were effected and some serious financial problems and litigation were settled. However, the serious decline in power revenues made the situation beyond all possible help under the original financial set-up. Among the problems solved during this period was the settlement of construction claims for $800,000, which was finally concluded by the claimants accepting district bonds at 90c. on the dollar, while the bonds were selling at that time at about 30c. on the dollar in the open market. The settlement for bonds was the only possible solution, as no money was available for a cash settlement.

To provide a basis for the inevitable program of refinancing, an independent engineer's report on the district and the ability of the land to carry an added financial load was obtained. Raymond Hill, consulting engineer, Los Angeles, after a two-year study of district conditions, presented a report with the following summarized conclusions: (1) The 108,000-acre-ft. water supply will be available annually except for one season of severe shortage to be expected every 25 years, based on the 1923-24 runoff as one of the lowest on record; (2) the mountain works are generally adequate and no additions are necessary for the present; (3) additions to the distribution system will be required for serving other lands in the district, but this work should be undertaken only in case of actual demand for irrigation water sufficient to render such improvement self-supporting; (4) the normal power revenue will be $438,000 annually until 1952, when a reduction in the contract price for power will reduce the net returns to about $240,000 per year; (5) the agricultural and general economic conditions are such that $30,000 per year is the maximum assessment that can be made against the land in the district under present conditions, and this assessment should not be increased faster than the spread in irrigated area. "Any greater continued assessment would result in heavy delinquencies, the prohibition of new development, and ultimate abandonment of areas now productive."

It was obvious from this report that it would be impossible to make up deficiencies by increased assessment. The only alternative was to reduce the fixed charges for the total outstanding indebtedness of about $8,100,000 to a point where the power revenue would be sufficient to cover interest and amortization. A substantial reduction in interest rate was essential, and the retirement schedule for the serial-bond issue required more flexibility to be feasible. This program necessitated a compromise between debtor and creditor and a change in the state law to permit issuance of sinking-fund bonds rather than the serial bonds required by the irrigation district act.

Legal preliminaries

Provision of the California Irrigation District Act, permitting only serial-bond financing for districts, was based apparently on the fear that management of irrigation districts would not be sufficiently responsible or enduring to carry out a sinking-fund program. The resulting security is inflexible and not particularly suited to the needs of irrigation financing because of inability to change the annual financial burden in respect to revenues. The history of irrigation district operation has proved that these organizations are stable, reliable and not lacking in integrity. To make sinking-fund bonds available for refinancing the Nevada Irrigation District, therefore, the 1931 state legislature passed a bill permitting this type of security.

At the same session of the legislature the act establishing the California District Securities Commission was passed, setting up a state board for the review and approval of district securities. Section 11 of this act provides that upon default in any payment a security-holder may apply to the commission, which upon investigation may declare the district insolvent and take over its operation and management as receiver.

Though the act had been passed prior to the refunding, the security holders questioned whether it would apply to refunding bonds or whether they would remain subject to the Irrigation District Act, which specifies that assessments must be levied annually to meet all financial requirements due and past due. The state supreme court in October, 1932, held that the refunding bonds would not be affected by the new act, since the section in controversy did not apply to bonds issued by a vote of the electors under the California Irrigation District Act. This solved the most serious legal point in the matter of refinancing.

Refinancing program

Before the default occurred, on July 1, 1931, a bondholders' committee was formed and negotiations were commenced between the district and this group. General features of the refinancing plan were arranged, and the district election on Dec. 14, 1931, approved by a 5:1 majority an $8,100,000 refunding issue of 4 per cent sinking-fund bonds. The reduction in interest rate from 5½ to 4 per cent effects a saving of $121,000 a year. Principal features of the refinancing plan are:

1. Each $1,000, 5½ per cent original bond deposited was to be exchanged for a $1,000 refunding bond maturing in 1977, the date of expiration of the present power contracts.

2. The new bonds carry 4 per cent interest but have supplemental coupons for 1½ per cent interest, which are to be paid provided there is excess revenue from certain definite sources above 4 per cent interest, sinking-fund and special sinking-fund requirements. These extra-interest coupons are not cumulative and are void if not paid each semi-annual period.

3. Interest (4 per cent) on the $8,100,000 refunding bonds will be $324,000, or $114,000 less than annual power revenue, until 1952. All power revenue is to be used only for meeting the refunded debt and a special reserve fund. No rights are waived by bondholers to levy assessments against the lands if required to meet fixed interest and principal.

4. A special reserve fund of $200,000 is to be built up and maintained out of excess power earnings for the express purpose of meeting the fixed interest in years of water shortage and of making emergency replacements and repairs to the mountain works to maintain water delivery for power. All ordinary maintenance and operating charges for the mountain division and the distribution system are to be met by an assessment levy of not less than $30,000 per year on the lands of the district and the income from sale of water for irrigation and to mines and municipalities.

5. The regular sinking fund for the retirement of the bonds is estimated to retire $4,865,000 principal amount of bonds by 1977. Provision is also made in the plan for redemption of the bonds either by call or by purchase in the open market.

The plan was sent to security-holders in August, 1931; by Dec. 15, 85 per cent of the bonds had been received from the 3,500 bondholders scattered throughout the country, many of them unfamiliar with the conditions at the time the bonds were purchased or at the time of default.

In the meantime, the bondholders' committee was convinced that the program would be successful but awaited the supreme court decision. Also the 1931-32 water supply showed improvement, being approximately double the previous year, and district revenues were up to normal. Finally on Oct. 14, 1932, the decision of the supreme court was released, and four days later the securities commission validated the new issue, and the refinancing program was completed with the distribution of the new bonds to those security-holders who had deposited the old bonds.

At the time the distribution was made about 98 per cent of the bonds had been deposited. This may be considered a satisfactory, or perhaps even an exceptional record. It is, of course, possible that some of those who still hold the old bonds may proceed to take legal steps in an attempt to force the district to pay them out. No such legal steps, however, are contemplated as far as the writer knows at the present time. The refinancing plan is a fair one and gives to the bondholder his share of what it is possible to earn from the total security behind his bonds. It seems only proper that when a very high percentage of the bonds has been deposited under such an agreement as is provided for in the present plan, the district should do all in its power to prevent the small outstanding fraction from gaining an advantage not given to those who have made it possible for the district to continue to function. If this were not done, the result would be that in every refinancing operation of this character there would be larger and larger numbers of people who would wish to profit at the expense of the others. If Nevada Irrigation District should, for instance, buy off the rest of its bonds, it may be imagined what chance other irrigation districts would have to put through any sort of a refunding deal. The result would be continued chaotic condition resulting in severe losses not only to th communities involved but to the bon holders as well. Nevada Irrigation Di trict has pioneered the way throughou in this refunding of irrigation distri securities, and now at the successful co clusion of its labors it would not wis to wreck other refunding operations b catering to the non-depositor.

The refunding plan has run th gauntlet of careful preparation, careful scrutiny by the securities commissio careful checking of the whole procedur by the state supreme court, and more de tailed investigation by over 98 per cen of the bond-holders who have accepte its provisions and who have raised ever possible objection before giving their consent to the exchange. It is therefor hoped that in this work we have bee able to set something of a pattern for the working out of the serious situation that confront many other irrigation and reclamation districts.

Fountain for Travelers on West Virginia Roads

Tested mountain springs are piped to pleasingly designed bubbling fountains and watering troughs located at the roadsides

By L. P. Street
Assistant Engineer, West Virginia Road Commission, Charleston, W. Va.

IN WEST VIRGINIA, as in other mountainous states, the broken and rugged topography that makes highway location difficult is coincidental with geological formations that are productive of springs. As a feature of roadside development, therefore, the highway department is building drinking fountains at many places.

After a spring has been found in a favorable location, it is observed through a period of dry weather to determine if the supply of water is sufficient at all times. Factors entering into the selection of a site are scenic beauty, shade trees and parking space.

The state health department is then notified of the location of the spring. A representative of this department is sent to sample the water and to inspect the surrounding territory for possible sources of pollution. If a favorable report is received from the health department, an agreement is entered into with the property owner conveying the water rights to the state.

At the source of the spring a supply basin similar to that in Fig. 2A is constructed. The top of the basin is covered with a concrete lid so constructed that it is not possible for surface or rain water to enter. The lid is held firmly in place by a hasp that is locked, so only persons connected with the road department can open the basin. The water enters through an intake pipe so placed that it is impossible for any surface water to enter at the intake. An overflow pipe is placed in the basin serving the double purpose of an air vent and of maintaining a fairly uniform pressure at the fountain. A waste pipe is placed near the bottom to be opened and used when the basin is washed and cleaned.

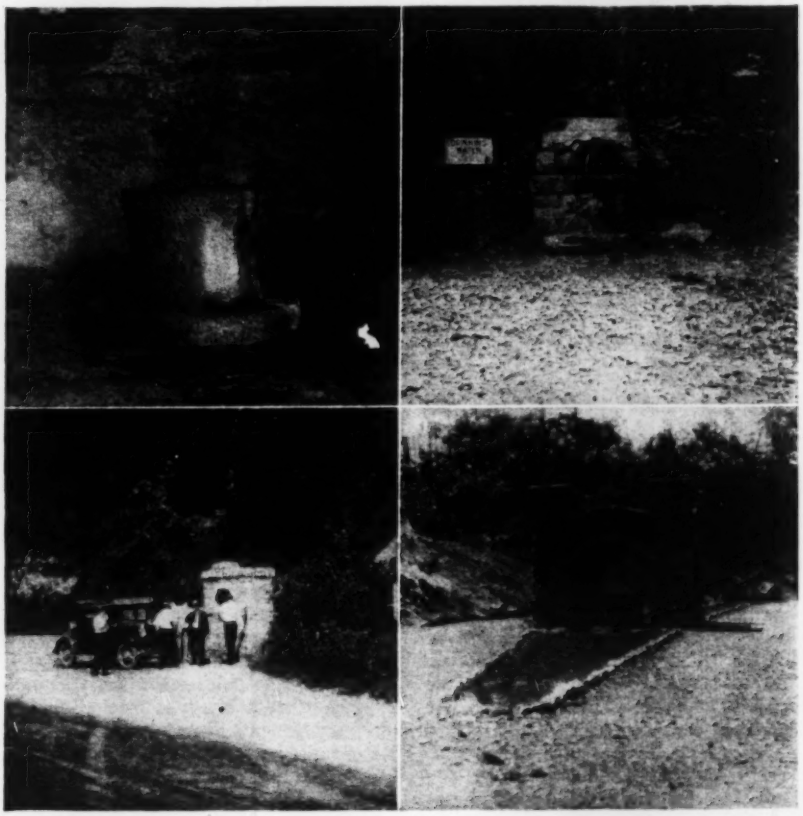
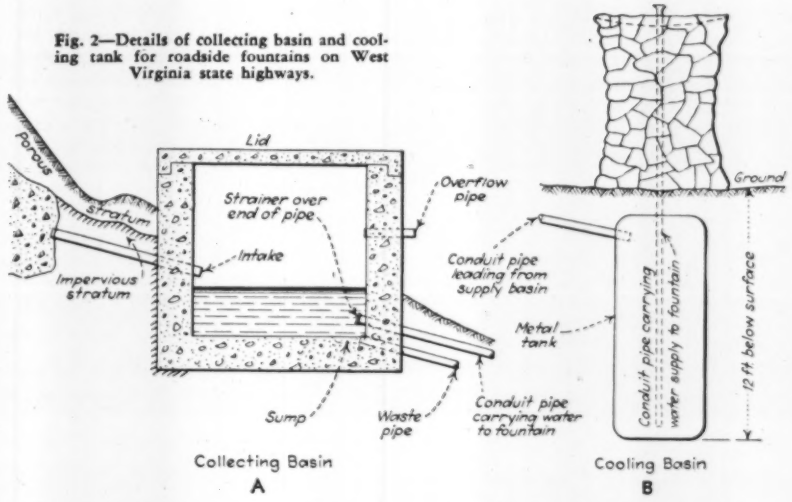


Fig. 1—Typical roadside drinking fountains constructed by the West Virginia road commission along main tourist highways.

Fig. 2—Details of collecting basin and cooling tank for roadside fountains on West Virginia state highways.



Where the supply basin is located a long distance from the fountain, the water becomes warm in the summer months before reaching the point of consumption. A cooling basin constructed as in Fig. 2B is placed at about a depth of 12 ft. and directly under the fountain. The warm water enters the top of this basin through the conduit pipe leading from the supply basin, the pressure forcing the cool water into the open pipe leading from the bottom of the cooling basin to the mouthpiece on the fountain. This method of cooling the water has proved to be very economical and effective.

Most springs occur where the groundwater in a porous stratum is brought to the surface by an impervious stratum, as shown in Fig. 2A. If the natural yield of a spring of this class is found to be insufficient, as is often the case in dry weather, it can be greatly increased by constructing a long collecting gallery running parrallel to the outcrop and leading to a central collecting basin. The most satisfactory type of collecting gallery is made by trenching into the impervious layer and laying a vitrified clay pipe provided with small openings. This pipe should be backfilled with gravel to a considerable height above the impervious layer.

A pipe leading from the drinking fountain carries the waste water to a water trough, which is built as an integral part of the fountain or located near by. This water is used to fill automobile radiators and as a drinking supply for animals.

In cold climates it is not advisable to develop a water supply that will not furnish a sufficient amount of water to keep a bubbler constantly flowing during the winter months. At points where the temperature falls as low as 10 deg. below zero it is found that a bubbler flowing constantly will not freeze.

As a safeguard against a supply becoming contaminated after it has been developed, quarterly samples are taken and forwarded to the state health department for analysis.

Height Limits for Tall Buildings Based on Plot Area

By Jacob Feld
Consulting Engineer, New York City

WHAT is the economic height of buildings? Believing that one answer to the question may lie in the relation of height to plot area, the writer recently made a survey of the 331 buildings in Manhattan, New York City, that are twenty or more stories in height. The tabulation is a summary, with separate grouping of residential buildings, including apartment houses, hotels, clubs and hospitals. If the Empire State Building is disregarded and a reasonable plot area is assumed for the RCA Building in Rockefeller Center, the plotting of all the average areas for the various story heights shows a fair grouping about the line whose equation is:

$$S \text{ (number of stories)} = \frac{\text{area of plot}}{700}$$

The weighted deviations from this line average 1.6 for points falling below and 1.5 for points above the line.

Considering the smallest lots for each story height from 20 to 26 inclusive, each with more than twenty examples, the average of these lots is 4,050 sq.ft. Of the 230 buildings of 20 to 26 (inclusive) stories in height, two are built on lots less than 3,000 sq.ft.; five on lots between 3,000 and 4,000 sq.ft.; ten on lots between 4,000 and 5,000 sq.ft.; fourteen on lots between 5,000 and 6,000 sq.ft.; and twelve on lots between 6,000 and 7,000 sq.ft. That is, about one-fifth of the buildings in this group are on lots of less than half the average plot area for these 230 buildings.

It is an interesting fact that, in spite of the 331 buildings that are more than nineteen stories in height, the average height of building per unit area of plot in Manhattan is less than six stories, and the total area that these buildings occupy is only 142 acres of the total 12,000 acres in Manhattan.

All Buildings			All Buildings		
No. Stories	No.	Aver. Area of Plot	No. Stories	No.	Aver. Area of Plot
20	75	13,800	40	5	14,700
21	26	10,700	41	3	23,200
22	35	19,300	43	4	35,300
23	27	13,400	44	2	12,025
24	20	17,600	45	2	27,800
25	26	17,400	46	1	13,900
26	21	23,200	48	1	13,200
27	6	19,600	50	3	40,100
28	5	26,600	51	1	25,000
29	4	29,100	53	1	40,800
30	9	28,700	55	1	30,200
31	8	13,600	56	1	29,700
32	9	17,800	58	1	21,000
33	6	34,600	66	1	31,700
35	11	25,200	70	2	63,650
36	7	22,600	77	1	37,200
38	5	16,600	85	1	84,000
			Total	331	

Residential Buildings		Residential Buildings	
No.	Aver. Area of Plot	No.	Aver. Area of Plot
18	19,900	2	21,200
6	10,600	2	12,900
11	15,800	1	30,000
5	25,200	2	19,100
3	17,700	2	13,100
6	12,200	2	15,200
6	24,000	2	12,700
3	15,600	2	20,200
1	39,800	2	58,000
1	12,000	0	.....
4	31,600	1	41,500
		Total 82	

Replacing Rubble in Road Ditches

Applying the results of soil erosion to road-ditch erosion, O. R. Zeasman, agricultural engineer for the Wisconsin College of Agriculture, replaced rubble ditch lining with a series of notch-spillway concrete check dams. He found the dams withstood floods greater than one in 1931 that washed out the stone and damaged the road. A 700-ft. stretch of ditch lined with rubble cost $2,800. The nineteen notch spillways that replaced the rubble cost $800. The head on each dam is 2.3 ft., and the fall is 0.2 ft. from the apron of one dam to the spillway of the next dam below. The aprons extend only 2 ft. downstream from the dam. The above is reported by E. R. Jones, Wisconsin state drainage engineer.

Beauty of Design Sought in Queens Parkway Bridges

In this third and last article of the series the completed bridges on Grand Central Parkway are described as illustrative of the types and the appearance of bridges planned for the complete Queens Borough Parkway

By C. U. Powell
Engineer in Charge, Topographical Bureau of Queens, Long Island City, New York

ALL INTERSECTIONS that are located on the Queens Borough parkway system (*ENR*, Feb. 16 and 23, 1933) require bridges. The greater number of these bridges are skew structures. Specifically three-fourths of them are at angles other than 90 deg., with angularity varying up to more than 50 deg. On Grand Central Parkway and its extensions only seven of the 35 principal bridges are at right angles. Seven others are skewed at from 1 to 9 deg.; five from 11 to 19 deg.; seven from 20 to 29 deg.; three from 32 to 40 deg., and six from 44 to a little over 52 deg.

Completed bridges

Of the bridges along Grand Central Parkway, between Kew Gardens and the line separating New York City from Nassau County, thirteen were completed in 1932. A fourteenth bridge, a short span, carries the parkway over an access drive leading into Alley Park. It is with the designs of these bridges—varying, as they do, with local conditions—that this article deals.

At four of the intersections, in the western portion of the 7-mile route, the parkway has been depressed to pass under the cross-streets. At the nine others the parkway is above the intersecting street. Of two future crossings one will be an underpass and one an overpass.

Fig. 1—Rigid-frame bridge, carrying Grand Central Parkway over Winchester Boulevard, is of reinforced concrete faced with sandstone of two shades of buff. The span is 66 ft.

Each bridge, whether overpass for the parkway or underpass, is designed to support, in each traffic lane, a live load equivalent to a 20-ton truck preceded and followed by 15-ton trucks, with four-fifths of the loads concentrated on the rear axles. Where the parkway is depressed below the cross-streets, the bridges have a clear span of 50 ft., to provide for the 44-ft. roadway and two 3-ft. walks. For those cases where the parkway is carried over, the spans vary according to local requirements.

In general, the several bridges are of the rigid-frame type built of reinforced concrete. Ornamental arch-ring stones of light gray granite, or of buff Clearfield County sandstone, rock-faced and with projections not greater than 3 in., are set with ¾-in. joints. Ornamental coping stones (granite or sandstone) have 1½-in. rock-face projections on top and edges. Ornamental quoin spandrels and panel frames on abutments and retaining walls also consist of rock-face dimension stones (granite or standstone) with 2½-in. projection.

For the 50-ft. spans the depth of the concrete arch at the crown is 18 in., or about 1/33 of the span, and 4½ ft. at the springing line. The rise is 4.6 ft. For appearance, the ring stones extend 2 in. below the intrados of the concrete arch. At Parsons Boulevard these ring stones have a minimum depth of 2 ft. with a 3-ft. keystone at the crown. At other crossings the crown ring stones are 2½ ft. deep.

Guard-rails are constructed of ornamental iron posts, bars and panels. A special treatment at one crossing, over the Long Island Motor Parkway, includes facia beams 34 ft. long and 31 in. wide, of unstained redwood. These are anchored into the concrete slab and, in turn, support the railing posts. Posts and rails, of the same material, extend along the wing walls to the end posts.

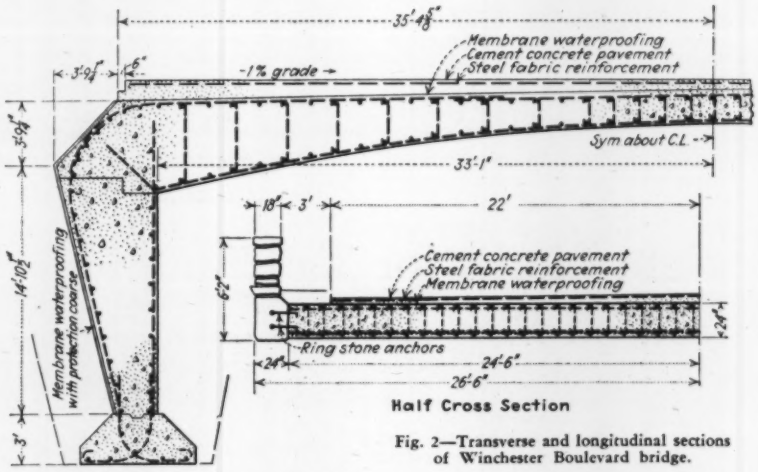
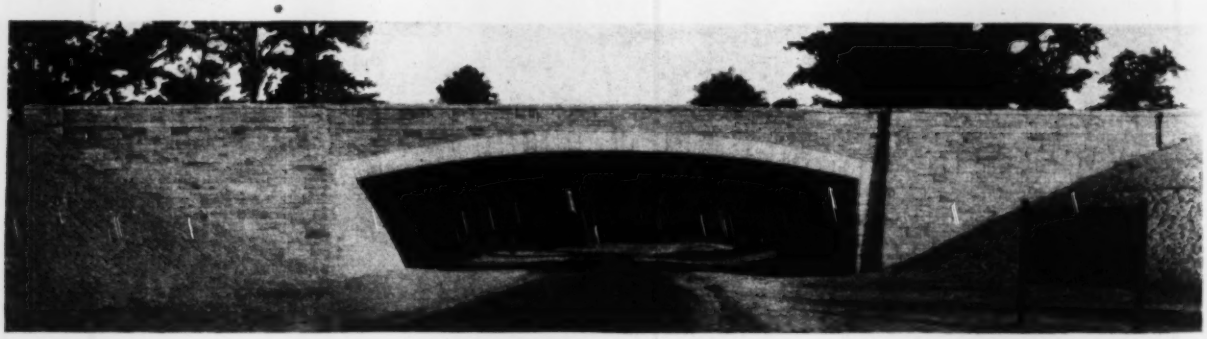


Fig. 2—Transverse and longitudinal sections of Winchester Boulevard bridge.

Most of the iron guard-rails consist of malleable iron posts about 7½ ft. apart, with rails and verticals of structural steel. At Hollis Court Boulevard, however, the balusters are of smoothed concrete.

Concrete pylons located at the skewbacks are used to ornament some of the bridges. This is the case at Hollis Court Boulevard and also at Springfield Boulevard and at Union Turnpike. At Hollis



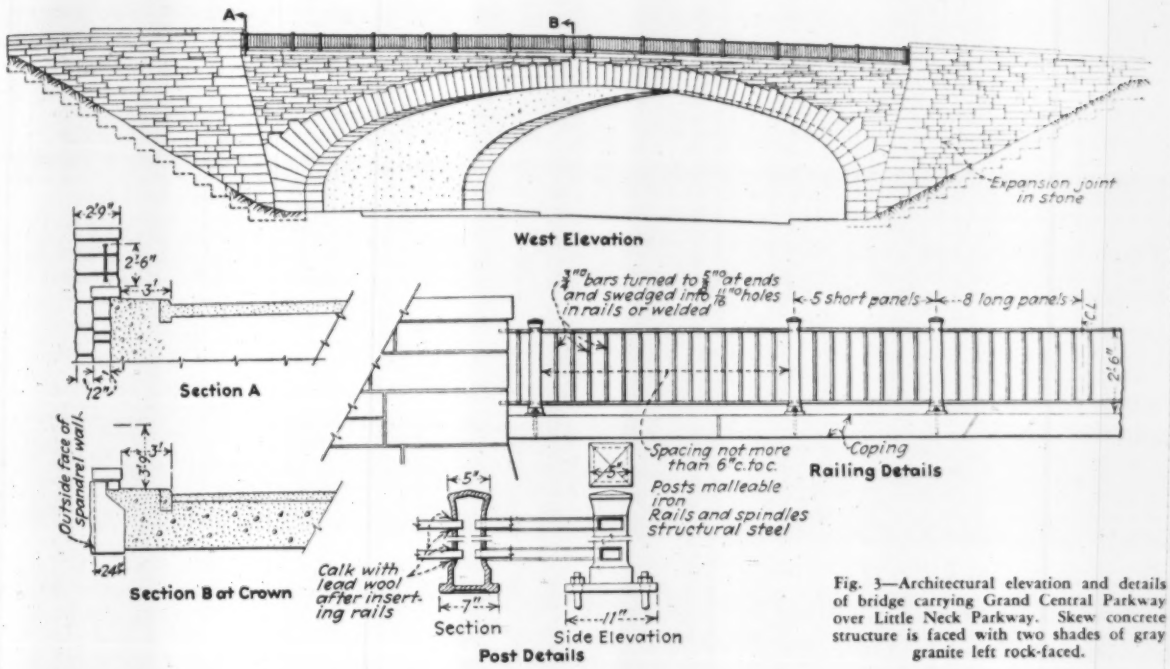


Fig. 3—Architectural elevation and details of bridge carrying Grand Central Parkway over Little Neck Parkway. Skew concrete structure is faced with two shades of gray granite left rock-faced.

Court there are also open spandrel arches (9 ft. 5 in. on centers) supported by concrete posts resting on the arch between the pylons and on foundation blocks between the pylon and the end posts. The arch ring, sprandrels, rails and balusters, as well as the pylons and end posts, are finished with smoothed concrete without stone facing. In the case of Springfield Boulevard the pylons, coping and end posts are ornamented with ashlar masonry of light gray granite, fine-finished, with projections not greater than ⅛ in.

Eight rigid-frame bridges

At Parsons Boulevard, 164th and 188th Sts., the arch barrel spanning the parkway is about 73 ft. wide to permit 50-ft. pavements and two 10-ft. walks to be carried across on a concrete deck slab with steel-fabric reinforcement. At 168th St., however, where there are only a 34-ft. pavement and two 8-ft. walks, a barrel width of 53 ft. 10 in. suffices. In all these cases the clearance line is 14 ft. above the parkway at the center and about 11 ft. at the curbs on either side.

Two bridges, where Grand Central Parkway is carried over the intersecting streets at Utopia Parkway and Midland Parkway, have clear spans of 60 ft., permitting for each cross-street a 44-ft. pavement and two 8-ft. walks. Here the concrete barrel is 2 ft. deep at the crown, with a 4-ft. rise. The clearance is 16 ft. at the center line, to the intrados of the ornamental stone arch ring, and 14 ft. at the curbs.

It should be noted that this 14 ft. is the standard minimum clearance for city streets, to allow for trucks. But the Grand Central Parkway will have no trucks on it, hence a smaller curb clearance is permissible where the parkway passes under the bridge.

A wider roadway on Winchester Boulevard, with 50-ft. pavement and two 8-ft. walks, makes the clear span of the rigid frame bridge (Figs. 1 and 2) 66 ft. The rise here is 3.8 ft. The barrel is 2 ft. deep at the crown and 5½ ft. deep at the springing line. The ring stones are 26 in. deep at the crown and about the same at the haunches. The abutments, vertical and finished with smoothed concrete, are keyed to reinforced-concrete footings 7 ft. wide and 3 ft. deep.

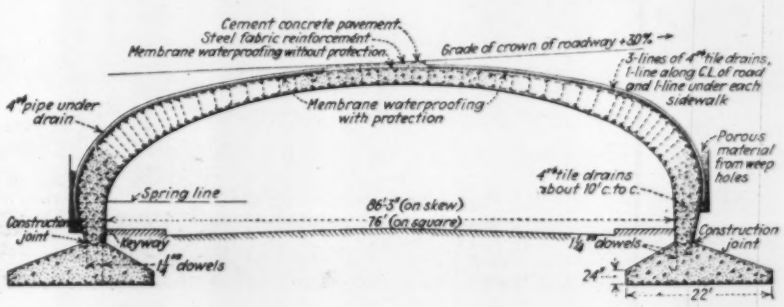
On this bridge a light buff sandstone, fine-pointed with ½-in. mortar joints, is used for ring stones, quoins at corners of abutments, belt courses and coping. The wing walls, of a slightly darker sandstone, are rock-faced, with projections not over 1 in., and ¾-in. mortar joints. The parapet walls are also of rock-faced sandstone, with 1-in. projections.

A clear span of 64 ft., with an elliptical arch opening carries 188th St. on a deck slab over the parkway, giving the standard 44-ft. pavement flanked by two 10-ft. strips of turf where the clearance is less than standard. The construction here is 20 in. deep at the crown, with a rise of 12 ft. above the springing line. Clearances of 14 ft. at center and 11 ft. at edges of the 44-ft. pavement are as before. The ring stones, 30 in. deep at the crown, extend 2 in. below the intrados of the arch concrete.

None of the bridges so far described has a skew angle exceeding 18½ deg. At Little Neck Parkway (Figs. 3 and 4), however, the bridge has a skew of about 28¼ deg. In this case also the clear span is considerably longer, being 76 ft. This accommodates a 60-ft. pavement and two 8-ft. walks. The frame here has a rise of 18¼ ft. above the springing line. Because of a 3 per cent grade along Grand Central Parkway at this point, the east springing line is 2 ft. higher than that at the west side—7½ ft. above the footings, in place of 5½ ft. The footings are 22 ft. wide and 6 ft. deep at the abutment.

On this bridge the concrete ring (Fig. 4) is made 28 in. deep at the crown and 5 ft. 4 in. at the skewbacks. The ring stones extend, as before, 2 in. below

Fig. 4—Longitudinal section of reinforced-concrete structure for Little Neck Parkway bridge.



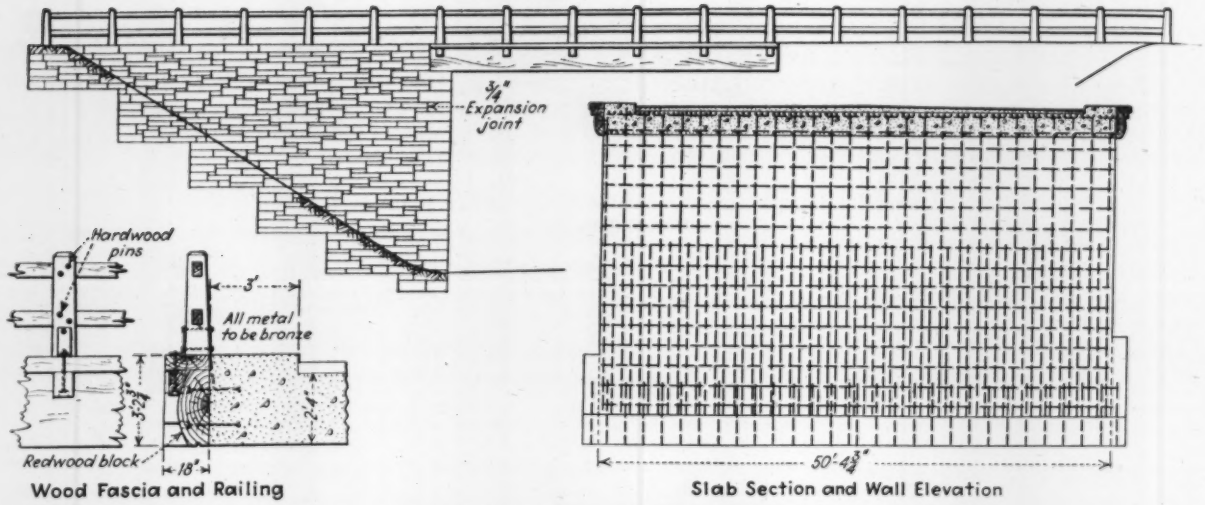


Fig. 5 — Bridge carrying Grand Central Parkway over Motor Parkway consists of reinforced-concrete flat slab integral with reinforced slab walls, forming a rigid U-shaped frame. Note the wood facia and railing.

the intrados of the concrete arch. A light gray granite, rock-faced, is used for coping, ring stones and quoins, with projections not over 3 in. Spandrels and wing walls feature a slightly darker granite, also rock-faced, and with projections not exceeding 4 in.

Reinforced-concrete flat slab

One crossing, with the shortest span of all, carries the Parkway over the Long Island Motor Parkway, a privately owned toll road, on a reinforced-concrete flat-slab structure (Fig. 5). With a clear span of only 30 ft., this slab has a thickness of 28 in., not including the 6-in. reinforced-concrete pavement. This slab is supported on reinforced-concrete walls 28 in. thick, 28 ft. high and 54 ft. long, extending 8½ ft. below the surface and anchored to foundation blocks 5 ft. wide and 3 ft. deep. Thus there is formed a rigid U-shaped frame structure. Minimum under-clearance at the center of the span is 17 ft., which, because of local ground conditions, is 3 ft. more than is required.

Open-spandrel crossing

What promised to be a most difficult crossing has been eased in the case of Hollis Court Boulevard by relocating the intersection 450 ft. to the west, and thereby straightening the line of the boulevard. This involved cutting through the brow of the ridge to a depth which at one point reached 55 ft.; but it resulted, also, in decreasing the maximum boulevard grade from 8 to 5 per cent, in surmounting what is the backbone of Long Island.

Here the parkway is carried on an overhead viaduct having a total length of 230 ft. The central part of this viaduct is supported above an open-spandrel, elliptical arch bridge (Fig. 6) having a clear span of 121 ft. and a rise of 32 ft. This structure consists of three reinforced-concrete arch ribs, each 30 in. deep at the crown and 8 ft. at the skewbacks. The two outer ribs, each 10 ft. wide, are spaced 9 ft. away from the central rib, which is 14 ft. wide, this making the bridge 52 ft. wide. The reinforced-concrete deck slab is supported on concrete posts 24 in. square, and set 9 ft. 5 in. between centers to correspond with the spacing of the spandrel arches.

Each of these main arches was poured in three sections—the haunches first and then the central portion. Dowel rods and a mortise joint unite the sections. The boulevard is carried through under them with clearance of 38 ft. at center and 33 ft. at the curb lines. As the span is 121 ft., it will be easy, when traffic demands it, to increase the width of the present 50-ft. pavement along the boulevard, flanked by its two 10-ft. sidewalks.

Fig. 6 — Open-spandrel elliptical concrete arch of 121-ft. span carrying Grand Central Parkway over Hollis Court Boulevard.

Plate girders for sharp skews

Three of the crossings for which bridges were built in 1932 involved skew angles from 45 to a little over 52 deg. In each case the structure consists of a plate-girder bridge with a solid concrete floor. And in each case, while spans and girder depths varied, the lower chords of the girders are curved in the form of an arch.

At Springfield Boulevard this type of bridge (Fig. 7) has a clear span of 60 ft.—perpendicular to the boulevard, of course—to provide for a 44-ft. pavement and two 8-ft. sidewalks. Seven main girders support Grand Central Parkway above, each 90 ft. long between bearing points. The exterior girders are 6 ft. 6½ in. deep, back to back of angles, and the arched lower chord has a rise of 2 ft. at the center. The floor beams are incased in concrete extending 1⅜ in. outside the edges of the coverplates. The deck slab is of reinforced concrete. The skew angle here is 45 deg.

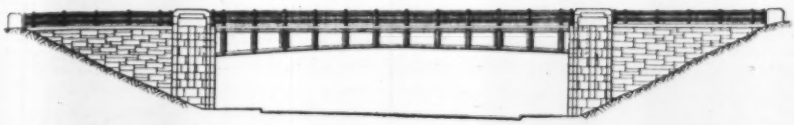


Fig. 7—Type of steel-plate girder span used at crossings having skews in excess of 45 deg. This span carries the parkway over Springfield Boulevard.

Union Turnpike, with a skew angle of 51 deg. 56 min., was handled differently. The turnpike has two one-way 30-ft. pavements, each flanked by one 8-ft. sidewalk. To cover this, the bridge has been given two 40½-ft. clear spans, separated by a center pier 13 ft. wide. Here the plate girders are 70 ft. long between bearing points, and the lower chord arches have a rise of 3 ft. at the center. Floor beams are incased in concrete.

Abutments and wing walls of this bridge are finished with a dressed concrete surface. The four pylons at the corners of abutments and wing walls are each 9 ft. long and 5 ft. wide. Piers and pylons are ornamented by split-faced granite of slightly varying color, laid in the work as random ashlar. Coping and belt courses are also of granite and are somewhat lighter in color. They are pointed and laid with ½-in. mortar joints.

Conditions at Commonwealth Boulevard are similar to those at Springfield Boulevard, each having a 44-ft. roadway with two 8-ft. sidewalks. But the skew angle at Commonwealth is the greatest of all, 52 deg. 6½ min. The span of 68 ft. between abutments is broken, but not in the same manner as at Union Turnpike. The sidewalks are in arcades, being separated from the roadway by bridge piers, each 4 ft. wide at curb level. Footings of both piers and abutments rest on pile foundations.

There are six steel-plate girders to carry Grand Central Parkway here, each 79 ft. 3½ in. long between bearing points and with an arch rise of 19 in. The exterior girders are 7 ft. deep, back to back of angles. The columns along the piers are connected by overhead arches. Coping and the ring stones forming the exterior of the sidewalk arcades are of light-colored granite, fine-pointed. The wing-wall granite is slightly darker.

Credit must be given to Robert W. Moses, president of the Long Island State Park Commission, for the fact of the state's cooperation in developing these parkways within the city. He has had a leading part in making this cooperation effective, whereby the state authorities allotted funds for the physical work on lands provided by New York City.

All of the maps connected with the development of Grand Central Parkway, as outlined in the first and second articles, were prepared in the Queens Topographical Bureau under the general supervision of the writer assisted by Albert E. Thomas, principal assistant engineer, and Albert H. Chandler, engineer of designs. The detailed plans for the parkway were made by the state highway engineers and engineers of the Long Island State Park Commission; and those for the bridges by the engineers of the state department at Albany. The state engineers made the contract drawings. All contracts for construction were awarded, pursuant to state law, by the state commissioner of highways.

Low-Cost Road Practices in North Atlantic States

Symposium of experience and experiment in surfacing for secondary and local roads by the highway engineers of seven North Atlantic coast states

SECONDARY and local roads occupy a special position in the states commonly considered as belonging to the North Atlantic group. Roadbuilding in these states compared with most remaining parts of the country is an old art. Road administration is often differently allocated, as witnessed by the predominance of township control in some states. In most of these states the concentrations of population (towns and villages) are frequent and traffic is heavy, so that the secondary road carries an amount of travel that would be considered main-road traffic in states of the South and Central West. It is in short a real thoroughfare. And all conditions indicate secondary and local road cost and quality standards that are justified in only occasional other states. Thus, official statements of low-cost road practice have a special interest. Below are summaries of a group of papers read at the recent convention of the Association of Highway Officials of the North Atlantic states.

* * *

Road Mix Gravel and Stone in Vermont

By H. E. Sargent
Commissioner, Department of Highways, Montpelier, Vt.

IN 1932 we built 57 miles of mixed-in-place road on the state highway system and 52 miles on state-aid roads. This surface is so far superior to surface-treated gravel that there is no comparison, and on many of our roads it will take the place of heavier pavements for many years.

The first and vitally important essential of a mixed-in-place pavement is adequate drainage and sub-base; 2½ per cent of our 1931 program failed last spring due to lack of this essential. Gravel or crushed stone 2 or 3 in. thick and bound with bituminous material is not rigid and has little or no structural strength; adequate base must be provided, which is usually gravel. To keep the cost down, a low-cost base must be utilized. For this reason a standard design and specification are not practicable. Local material for base and surface must be used, and this requires quite often a special design and specification for the base and surface.

Experience has proved that we should have a slightly lean mix and a tight seal; the lean mix is more stable immediately after construction, and a tight seal is necessary to withstand spring conditions in Vermont. The cost of washing the gravel is more than justified. The best results have been obtained with gravels having a per cent of wear of not more than 16. We have used on state-aid roads gravel having as high as 40 per cent wear.

The quality of the sand used in the mix is of more importance than that of the coarse material. It should be clean and as free from fine material as possible. The coarser it is the better the results. It should have a fineness modulus of 3 or more, and not more than 5 should pass 100 mesh. On the larger jobs it pays to separate the sand from the stone and recombine it so as to get definite proportions. From 20 to 30 per cent of sand gives the best results; with a very coarse sand as much as 50 per cent may be used. The stone is the life of the road, the sand and tar being merely a binder. Too much sand or tar will cause instability and bunching.

In building crushed-stone surfaces we prefer mixed-in-place to penetration even when 2½-in. stone is used. It is cheaper, faster to lay, and makes a much smoother-riding road. Our prac-

tice is to use tar with gravel and cutback asphalt with crushed stone.

The maintenance cost is less than for surface-treated roads, retreatment in 1932 averaging about $425 per mile. In 1931 our costs per mile for the surface were $3,600 for gravel 2 in. thick and $5,600 for stone 2½ in. thick. This type of surface on our state-aid roads costs from $2,000 to $3,000 per mile. Crushed-stone surfaces 3 in. thick cost from $4,500 to $6,300 per mile.

* * *

Surface-Treated Gravel in New Jersey

By E. E. Reed
Assistant State Highway Engineer, Trenton, N. J.

GRAVEL roads that have not been treated are unsatisfactory in both wet and dry weather. They are in their best conditions when moist. It is necessary, therefore, to give them a surface treatment of some kind. The following have been most used in New Jersey.

Slow-Curing Oil — The slow-curing oil is applied to the road in two separate applications, the first at the rate of 0.5 to 0.7 gal. per square yard. When the material has penetrated the gravel surface, it is covered with 25 lb. of sand per square yard. Four to six weeks later the second application is made at the rate of 0.3 gal. per square yard and again covered with 25 lb. of sand per square yard. It is necessary to drag the road after each application of sand and to continue dragging for ten days or more after the final application until the oil has set. The cost of this treatment is from $650 to $900 per mile for two applications. For retreatment work (only one application of oil and sand) the price will range from $325 to $450 per mile for a 20-in. width.

Heavy Cutback Asphalt—This treatment has been used on roads that have been previously treated with slow-curing oil and consists of the application to the oiled surface at the rate of 0.5 gal. per square yard. The material is then covered with 30 to 40 lb. of ⅜-in. stone per square yard. Pea gravel or slag may be used instead of the stone. The cover is then rolled. This treatment will cost from $1,600 to $2,000 per mile, 20 ft. in width. The resulting surface has a hard uniform stony appearance and is non-skid.

Tar—This may be used on an untreated gravel road or on one that has been previously treated with slow-curing oil. In the case of a road that has not been previously treated it is necessary to apply a prime coat of cold tar at the rate of 0.4 to 0.5 gal. per square yard. When this has penetrated the gravel surface, hot tar is applied at the rate of 0.3 to 0.4 gal. per square yard, and this is covered with ⅜-in. stone, pea gravel or slag at the rate of 25 to 35 lb. per square yard. This treatment for one application on a road previously treated will cost from $1,700 to $2,700 per mile, and for two treatments about $3,200 to $3,600 per mile. The result is a hard stony surface that is not slippery in wet weather.

* * *

Emulsion-Penetrated Stone in Maine

By E. L. Merrill
Assistant Engineer, Maine Highway Commission, Augusta, Me.

THERE is a considerable road mileage in Maine where the traffic census shows a fairly large number of vehicles per day with a small percentage of trucks, and on this mileage a lighter type of pavement is ample.

After experimenting considerably during the past three years, we have had very satisfactory results with a 3-in. compacted thickness of emulsified-asphalt penetration with the crushed-stone base omitted. It is necessary to use local stone of fairly soft granite, and emulsified asphalt adapts itself very readily to this type of stone since no particular harm is done if the stone breaks up some under the roller, as the asphalt will readily penetrate and coat all of the stone. Our construction season is short, and the use of this material allows us to work quite late in the fall with good results.

In constructing an unimproved section the road is graded and a bank-run gravel base is put in from 12- to 18-in. compact depth, according to the nature of the subsoil. After the base is brought to grade and compacted, it is given a surface treatment of tar from 0.5 to 0.6 gal. per square yard and in two applications. Whenever possible, the base is allowed to lay over during the winter so that fills will be thoroughly compacted and the base well consolidated.

Upon the surface-treated gravel base there is spread sufficient crushed stone for a 3-in. compacted depth. This stone will pass a 2½-in. screen and be retained on a 1-in. screen. After the surface has been rolled and keyed together, emulsified asphalt is applied at the rate of 1 gal. per square yard. Immediately after the emulsion has been applied and before it has had time to break, clean keystone (½ to 1 in.) is spread uniformly over the surface, hand-broomed and rolled.

After the first application has had time to break, a second surfacing of 1 gal. per square is applied, and before it has had time to break, it is covered uniformly with enough keystone to fill the voids. The surface is then thoroughly rolled and broom-dragged. The following day the course is thoroughly and systematically rolled, beginning at the shoulders and finishing at the crown.

Two seal coats follow at about 24-hour intervals. For each coat after the surface has been compacted, it is swept clean and 0.3 gal. of emulsified asphalt per square yard is applied evenly. As soon as the emulsion breaks, it is uniformly covered with clean stone chips in a quantity sufficient to take up all excess bituminous material, after which it is well broomed with a broom drag and rolled.

The above described type of pavement has been built in Maine at the following costs:

Using local field stone for crushing, the cost per square yard of the stone in place was	$0.23
Cost per square yard of emulsified asphalt (2.6 gal.) furnished and applied, at 0.1026 per gal.	0.29
Total cost of pavement per square yard	$0.52

* * *

Oiled Bank-Run Gravel in Maryland

By C. B. Bryant
Materials Engineer, State Road Commission, Baltimore, Md.

IN THAT portion of Maryland, south of a line from Annapolis to Washington, D. C., and between the Potomac River and Chesapeake Bay, are deposits of gravel, which it has been found possible to use in the construction of a type of run of bank-gravel road economical in first cost and moderate in maintenance.

Grading and drainage is first taken care of the same way as for any improved road. After the subgrade has been prepared, it is covered with loose gravel that is consolidated by dragging and compaction of traffic. The material used has a maximum size of 2½ in. and a minimum size limited by the amount of material passing the ¼-in. or ½-in. screen. The thickness of this base is from 5 to 7½ in., the greater thickness being used for those gravels containing a larger amount of fine particles. When the base course appears to have become well consolidated and established, the surface course, which is the same type of gravel, is applied loose to a uniform depth of 4 in. This is shaped and dragged the same as the base course, and traffic is given access to it throughout this period. Intensive maintenance by frequent dragging is carried on throughout the succeeding winter, during which time the road becomes well consolidated, and any points of weakness not corrected during the construction of the base course are eliminated.

During the season following original construction the roads of this character are given a surface treatment of bituminous materials as follows: A power-driven road machine goes over the road and removes all corrugations, high spots or loose material, leaving the removed material in a windrow on the earth shoulder. The surface is then swept to remove any remaining loose material and dust. This is followed by a treatment of ½ gal. per square yard with a medium-curing asphalt primer. This is

covered within a few minutes after application by casting over the surface of the road approximately 20 lb. per square yard of the loose material that has been bladed off the road. As soon as this initial priming treatment has cured, which varies from about a week to as much as a month, a second application of the same priming material is made at the rate of ¼ gal. per square yard, this application also being covered with the gravel removed by blading, rolling and broom-dragging.

The costs of these roads in original construction is from $1,300 to $1,900 per mile of 16-ft. road at the present time, not including grading or drainage. The first-year surface treatment, covering the double application of priming material with two covers, costs about $750 per mile; and the final surface treatment, covering a single bituminous application with a chip cover, costs about $480 per mile. This makes the total cost of the completed road from $2,600 to $3,000 per mile.

* * *

Traffic-Bound Macadam in Delaware

By Wm. A. McWilliams
Resident Engineer, State Highway Department, Dover, Del.

AFTER the roadway has been graded and honed to conform to the typical section, surfacing material consisting of stone screenings, small-size stone or slag is added at the rate of 500 tons per mile. With slag aggregate graded from 1 in. down to the No. 10 sieve, 500 tons will lay 1 mile of roadway 2 in. loose and 14 ft. wide; 25 per cent must be added if stone is used, due to the increase in weight. This material is generally spread by large trucks dumping directly on the subgrade; a two-by-four laid longitudinally along the center line, with the 4-in. face resting on the subgrade, is used as a templet. The material is then moved to each side until the required thickness is obtained. Two methods may be used in compacting this material. One is to maintain the loose layer until traffic compacts it; the other is to scarify lightly the surface material into the subgade. Contracts let in 1932 for 44 miles were from $2,000 to $2,300 per mile.

* * *

Low-Cost Waterbound Macadam in Connecticut

By A. W. Bushell
Engineer, Contracts and Construction, State Highway Department, Hartford, Conn.

CONNECTICUT still builds waterbound macadam. These roads are surface-treated with tar. Generally, standard high-type construction is employed. However, as a measure of economy, a few of the towns in Connecticut have developed a much cheaper method of manipulation for stone-surfaced roads during the past two years. These towns are situated either where there is no available gravel or where the gravel banks have an excess of sand in them.

This method is very similar to the building of a loose gravel road, in that a subgrade is prepared simply by a scraper throwing up a windrow on each side to form a shoulder, the grading machine taking out the small inequalities in the profile of the road. On this prepared subgrade is placed a 6-in. course of loose 1¼-in. stone, which is distributed and smoothed out by hand labor. On top of this loose stone is placed 3 to 4 in. of stone screenings. The road is started at the end nearest the source of supply so that, in delivering the stone or screenings, the trucks pass over the stone that has already been laid. A scraper keeps shaping the road, keeping the ruts from forming so that the screenings shake down through the stone and form a compact mass. Between the rains that fall and the use of the scraper, eventually a macadam road is obtained without the use of a roller or watering cart, which compares quite favorably with the road obtained by standard methods. This method cannot be followed where there is considerable high-speed traffic or where time of completion is an important element, but roads have been obtained by this method which, upon being surface-treated, have been economical in that they were built by local town labor with equipment that they had on hand and without the spending of their money for the hiring of outside equipment or outside skilled labor. The road is satisfactory in that it presents a smooth dustless surface capable of carrying all-year-round traffic. Roads of the above type with a travel path 16 ft. wide have been built during the past two years for 95c. to $1 per running foot, exclusive of the surface treatment.

* * *

Road Mix and Penetration Combined in New York

By E. C. Lawton
Assistant Commissioner of Highways, State of New York, Albany, N. Y.

ABOUT 475 miles of bituminous road-mix construction was completed in New York on state roads in 1932. The kinds of bituminous materials used and quantities and costs are given in the accompanying data. A variation from normal road-mix methods was employed in using asphalt emulsion.

The asphaltic emulsion used for retread was a slow-breaking type of emulsion (about 2½ hours), which is necessary in order that the bituminous material will not set up before it is properly mixed with the stone.

Asphalt emulsion of this slow-breaking type may be used for the second application and seal coat, but the work would be expedited by using a quick-breaking (about 30 min.) emulsion for the second application and seal.

The first application of emulsion consists of about 1 gal. per square yard of the slow-breaking type of emulsion. The stone and emulsion are then mixed, but care should be taken that the mixing process is not continued for too long a period, as continued mixing will remove the bituminous material from the stone rather than aid in its distribution over the stone surfaces.

When the mixing has been completed the mixture is immediately spread over the road surface with the grader, brought to the desired contour, given a uniform coating of stone chips, rolled and broom-dragged.

The second application of emulsion of 0.6 gal. per square yard is then made for the purpose of penetration. The surface is then chinked and rolled.

The loose stone chips are swept from the road surface, and the seal coat of 0.3 gal. per square yard of emulsion is applied. Stone chips are applied, and the road is rolled and broom-dragged.

Brick Incasement Increases Steel Column Strength

Tests made at the Bureau of Standards and reported in the Bureau's *Journal of Research* for January, 1933, indicate that steel columns incased in brick walls have a strength equal for practical purposes to the tensile yield point multiplied by their cross-sectional area. The tests included three 6-in., 20-lb., H-section columns 23 ft. long having flat ends, and six similar columns incased in brick walls 14 in. thick 6 ft. long and carried up to about 8 in. from the top of the steel column. The six incased columns were divided into two groups of three each, depending upon the orientation of the steel column in the brick wall. The compressometer readings over a 150-in. gage length centered at mid-height showed that the steel in the incased columns was stressed on the average less than 20 per cent as much as was the steel in the bare columns for the same load. The lateral deflection of the incased columns was very small, and the brickwork was not appreciably affected by the tests. In no case did the lateral deflection exceed 0.03 in. under the maximum load. The orientation of the steel column with respect to the face of the brick wall had no effect upon the strength of the incased columns.

The tests were made at the request of the engineer department, District of Columbia, Washington, D. C. They were carried out under the direction of H. L. Whittemore. The report is signed by Albert L. Harris, A. H. Stang and J. W. McBurney.

New Facts About Cement and Concrete—I

Abstracts of some A.C.I. papers give the first published results of the elaborate research program that is guiding the construction of Hoover Dam

OUTSTANDING in importance among the papers presented at the American Concrete Institute's Chicago meeting two weeks ago was information on composition and properties of the new low-heat cements. These cements, developed during the past year primarily for the heavy masses of concrete in Hoover Dam, give promise of proving valuable in a much broader field of use. Interest also attached to the discussion of high-frequency vibration of concrete, by which a very dry, stiff mix can be placed successfully, and a strong, homogeneous concrete can be produced with a saving of cement. Abstracts of papers covering this phase

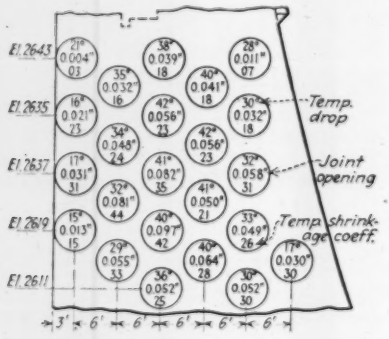


Fig. 1—Shrinkage measured on Owyhee Dam test section from May 13 to June 27, 1932, showed average shrinkage coefficient of 0.0000025 per degree F. The vertical contraction joint opened 0.044 in., and the temperature drop was 30 deg. F. on the average.

of the convention program will be published next week in the second installment of this report. Eight papers outlined the methods and present results of the Hoover Dam researches dealing with cement and concrete properties. All but one of these papers are here abstracted. In the eighth, Harmon S. Meissner described the "calorimeter rooms" built at Denver, in which concrete specimens inclosed in sealed metal cases harden under adiabatic conditions —i.e., with no inflow or outflow of heat from the specimen. Sensitive heat-indicating instruments and control apparatus, with refrigeration and heating, maintain the air surrounding the specimen at a temperature exactly equal to that within the specimen. This method of curing was necessary to reveal the properties that concrete will acquire in the interior of the dam, where it will set under substantially adiabatic conditions and without loss of moisture.

Shrinkage in cooling

Temperature shrinkage in relation to the opening of vertical contraction joints was studied at Owyhee Dam. This shrinkage and the grouting of the resulting joint openings control the action of thick arch dams, since the arch elements cannot act as arches until the cantilever elements have deflected far enough to close the vertical joints and bring the arch blocks into bearing. If, during construction of the dam, the joints open wide enough to permit of thorough grouting, a monolithic structure may be produced and full arch action assured.

The shrinkage studies, reported by B. W. Steele, engineer of dams, Bureau of Reclamation, were made by embedding a pipe cooling system in the adjacent panels near the top of Owyhee Dam during its construction, covering an area 100 ft. long by 82 ft. high and on the average 35 ft. thick. After river water had been pumped through the pipes for 40 days, the average temperautre drop for the lower two-thirds of the test section was 30 deg. F., the joint opening 0.044 in., and the temperature shrinkage coefficient computed from these figures 0.0000025. This value was checked by direct measurement of shrinkage in the two panels by invar bars and strain meters, which indicated a coefficient of 0.000003. Further, cores drilled from Gibson Dam across contraction joints that had been grouted enabled the thicknesses of acutal grout films to be measured, and these checked the Owyhee measurements (Figs. 1 and 2).

Thus the average temperature shrinkage coefficient obtained in the field is only about half the coefficient of expansion or contraction measured in the laboratory. This is considered to be due largely to restraint and to the relief of residual compression present in the concrete when cooling began.

Joint grouting

Grouting practice was studied at Denver, by varying the fineness of the cement, the water-cement ratio of the grout, the joint width and the applied grouting pressure. For this investigation a split cylinder of mass concrete 5 ft. in diameter by 7 ft. high, cast to simulate a contraction joint in a dam, was so constructed that the thickness of grout film could be easily and accurately controlled. These studies yielded the following pertinent facts:

1. In order to obtain satisfactory flowage in grouting a contraction joint, the cement should be passed through a 200-mesh sieve immediately before the grout is mixed.

2. For cracks of the order of 0.05 in.,

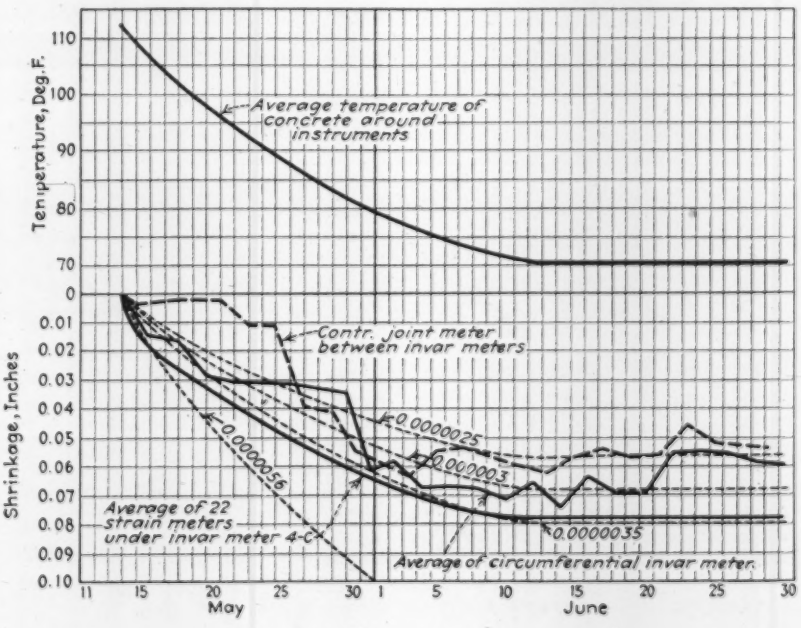


Fig. 2—Owyhee shrinkage measurements compared with temperatures and computed shrinkage for various coefficients indicate an average value between 0.0000025 and 0.0000030.

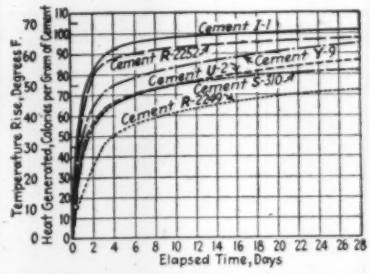


Fig. 3—Differences in heat generation of six commercial cements, as measured on adiabatically cured specimens of concrete of 1:9.5 mix containing 1 bbl. of cement per cubic yard, with water-cement ratio 0.56 (slump 3 in.). Starting temperature 70 deg. F. Same curves, using outside scale, give temperature rise.

a grout in which the ratio of water to cement is as 75 to 100 by volume gives the most desirable film. A water-cement ratio of 1.00 contains too much free water that cannot be forced into the concrete or otherwise dissipated.

3. Joint pressure of 90 per cent efficiency and joint coverage of 99 per cent are easily obtained with a grout of water-cement ratio of 0.75 and with a film thickness of the order of 0.015 in.

4. Increasing the pressure within the joint immediately after it was filled did not appreciably increase the shearing value of the grout film.

5. The average shearing value at 28 days of films, fog-cured at 70 deg. F., was 900 lb. per sq.in.

Effect of cement composition

Results of tests on seven commercial cements, selected for exhaustive test after investigation of a large number of cements at the University of California, were reported by Robert F. Blanks, of the Denver laboratory of the Bureau of Reclamation. These tests include heat of hydration, strength, volume change under adiabatic curing in sealed copper jackets, plastic flow under sustained stresss of 200, 400 and 600 lb. per sq.in., and permeability studies.

Heat generated during hydration, as shown by Fig. 3, varies over a wide range. It was measured on large cylinders cast in sheet-metal containers that were sealed after casting and stored in adiabatic calorimeter rooms with automatic control of room temperature to equal the temperature of the specimen (within an accuracy of 0.1 deg. F.). This is considered to be closely similar to the curing condition of concrete in the interior of the dam. Temperature-rise cycles were started at 40, 70 and 100 deg. F., those shown being for 70 deg.

In Fig. 3 the cements of highest heat generation contain high percentages of tricalcium silicate and tricalcium aluminate, while the low-heat cements are those with high dicalcium silicate. "The upper curve is characteristic of modern high-early-strength cement, while the lower curve is near the lower limit of a low-heat cement that will also possess the necessary degree of strength development and be practicable of commercial production."

Corresponding crushing strengths, measured on 6x12-in. cylinders, are shown in Fig. 4. "High or low heat of hydration is in general indicative of high or low compressive strength. It will be seen that at 28 days the strengths developed by the mass-cured cylinders are considerably higher than for standard curing. However, the indications are that at 90 days the difference is materially reduced, and at even later ages the reverse is more generally the rule. Another important fact is the consistent gain in strength over a long period of time of the low-heat cements as compared with the high-early-strength development and subsequent slow gain of the higher-heat cements."

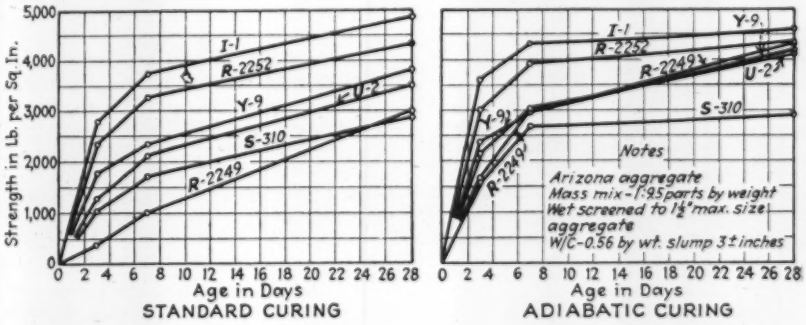


Fig. 4—Curing conditions have profound effect on rate of strength increase of concrete. Adiabatic curing, in which the heat generated is retained in the concrete, represents approximately the condition prevailing in the interior of a large mass, such as Hoover Dam. Three of the low-heat cements (see Fig. 3) show good gain in strength under these conditions.

Fig. 5. summarizes data on the contribution of the principal compounds in cement to the heat of hydration and strength, as obtained in the California investigations. Tricalcium aluminate contributes most heat but little strength; tricalcium silicate gives most of the early strength, dicalcium silicate most of the strength at later ages.

Aggregate and specimen size

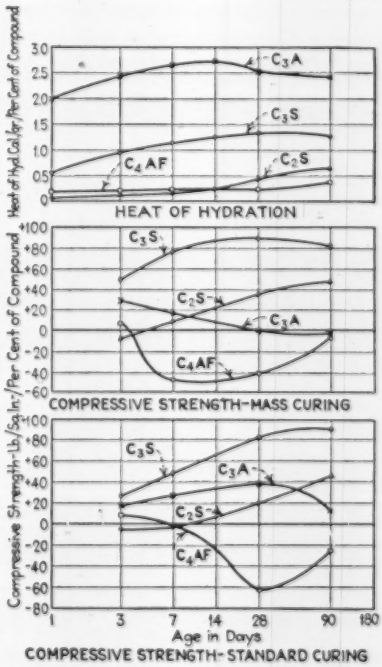
In previous large Reclamation Bureau-dams, concrete containing aggregate as large as could be handled through the mixer (9-in. maximum size) has been used, and such concrete is to be used also in Hoover Dam. Data on the strength of such concrete are lacking, although strength tests have been made on specimens molded after screening out the large cobbles ("wet-screened"). Tests of the full mass mix were therefor thought necessary, to determine strength and tightness. For such tests the crushing specimens must be at least 36 in. in diameter, on the usual basis of diameter equal to four times the size of largest aggregate. A 4,000,000-lb. testing machine was installed at Denver for the tests. Information on the size effect of specimen was also required. Arthur Ruettgers, of the Denver laboratory, reported the results obtained up to now in this work.

Make-up of cylinders

All specimens were mixed to 3-in. slump, cured in fog rooms at 70 deg. F., and ends were ground plane before testing, although 6x12 in. cylinders showed about equal strength whether ground, capped with sulphur and fire-clay compound or capped with portland or aluminate neat cement. As uniform head travel of the testing machine gave variable results, a device to assure uniform rate of loading (17 lb. per sq.in. per sec.) was developed.

The aggregate used is from the source of Hoover Dam aggregate, the "Arizona gravel deposit," a water-borne mass of gravel ranging up to 12-in. size, the sand being quartz, while the larger material is limestone mixed with

Fig. 5—How the four chief compounds in cement contribute to heat generation and strength. Note the difference in strength effect between normal and mass curing.



Figs. 6 and 7—One of the large test cylinders, 36x72 in., crushed in the 4,000,000-lb. Denver testing machine, and typical cores from 36-, 24-, 12- and 8-in. cylinders. The large cylinder was of 1 : 2.45 : 7.05 mix by weight, with largest aggregate 9 in. in diameter, water ratio 0.81 by volume and a 3-in. slump.

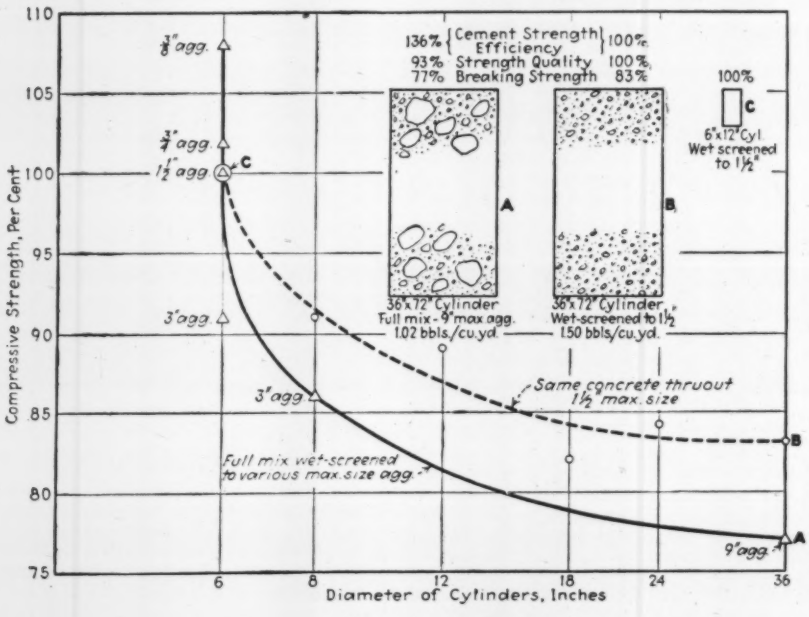
granite, basalt and quartzite. For the strength tests three basic mixes were made, with 1.2, 1.0 and 0.8 bbl. of cement per cubic yard, partly with aggregates ranging from ¾-in. to 9-in. maximum size and partly wet-screened from largest-size mix to mixes with maximum size of ⅜, ¾, 1½, 3 and 6 in. Test cylinders are of seven sizes, ranging from 3x6-in. to 3x6-ft. The permeability tests are made on cylinders varying from 6x6-in. to 18x18-in. size, tested under pressures up to 450 lb. per sq.in. while sealed with asphalt into cast-steel containers so that the travel of the water is endwise.

In the cylinder crushing tests, double-cone breaks are general (Figs. 6 and 7). The large cylinders are most uniform in strength. Results to date give the curves shown in Fig. 8, representing full-mix and wet-screened concretes tested in appropriate-size specimens. Beginning with the full mix with 9-in. cobbles, tested in 36x72-in. cylinders, removal of the large stones raises the strength (in smaller specimens). Mr. Ruettgers says, "The large differences in strength cannot well be attributed wholly to differences in mix proportions resulting from wet-screening, since, by examining the broken-line curve, which applies only to 1½-in. wet-screened concrete tested in cylinders of varying size, it is evident that the strength falls off materially as the size of the test specimen increases."

As the large cylinders with large aggregate contain less cement (1.02 bbl. per cubic-yard. in the 36x72 in. cylinder with full mix, against 1.50 bbl. for the same size cylinder with 1½-in. wet-screened concrete), the strength efficiency of the full mix, rated on equal amounts of cement, is the greater by 36 per cent. Wet-screening to small size of aggregate and testing in equal-sized cylinders appears to decrease not only the strength but also the elastic modulus. On the other hand, cylinder size itself does not appear to influence either this modulus or the ratio of lateral contraction. No explanation has yet been obtained of the lower strength of large cylinders.

Permeability results are not yet conclusive, but a single test on an 18x18-in. full-mix specimen under high pressure gave lower permeability than expected, and indicated that at the 650-ft. base of Hoover Dam "a thousand years or more would be required for water to permeate the concrete."

Fig. 8—How crushing strengths change with size of test cylinder and size of aggregate. The 36x72-in. cylinder with 9-in. cobbles in its mix has only 77 per cent the strength of the 6x12-in. cylinder with 1½-in. maximum aggregate.



Measuring elasticity

Elastic properties of cylinders were measured in conjunction with strength. As described by E. N. Vidal, of the Denver laboratory of the Bureau of Reclamation, the apparatus consists of clamp-frame compressometers for 8-in. and smaller cylinders, and individual dial-indicator strain gages for larger specimens; similar instruments measured the lateral deformations. All specimens were preloaded to about one-fourth ultimate strength before the elasticity measurements.

In this work it was found that within 25 to 30 per cent of ultimate the stress-strain curve is a straight line for all mixes and sizes; that the second and succeeding loadings show close agreement in elastic properties; that dial indicators must be calibrated periodically; and that uniform bearing is essential (ends ground plane to within 0.002 in.).

Field-control test

An eight-hour compressive-strength test procedure for use in field control of concrete, described by O. G. Patch, of the Boulder City, Nev., staff of the Bureau of Reclamation, has been found to check closely with 7- and 28-day tests. For the test the specimen, while inclosed in its molding cylinder, is cured seven hours in a standard quantity of

hot water beginning at standard temperature in an insulated vat of standard heat-retaining capacity. The hot-water curing begins ½ hour after the concrete is discharged from the mixer; after the seven-hour hot-water curing it is allowed to cool one hour in the 70-deg. moist room and then is broken, eight hours from the mixer.

The curing vat (Fig.9) comprises an internal tank 14 in. in diameter by 22½ in. high, filled 19 in. deep with water; a wooden outer container, which provides for a 3-in. layer of rock-wool insulation under and around the tank; a tight cover; a 3,000-watt heater element in the lower part of the tank; and a support for the molding cylinder and specimen in the tank, high enough to keep the top of the cylinder just above the raised water level. Before the specimen is set in, the water is heated to the boiling point; then the overflow is closed, the heater turned off, the specimen inclosed in its molding cylinder, placed, and the lid put on. During the seven-hour curing no heat is applied, but the water cools from about 195 deg. F. after the specimen has warmed up to about 175 deg.

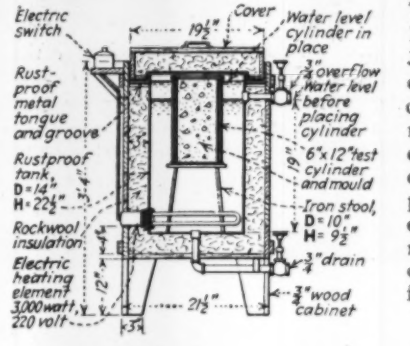


Fig. 9—Tank for eight-hour field-control test of concrete. The water is heated to boiling, the heater turned off, the overflow closed, the half-hour-old specimen inclosed in its mold is placed on the stand, the insulating cover is put on, and the specimen is left in place seven hours before removal. It is then cooled one hour in the 70-deg. moist room and crushed.

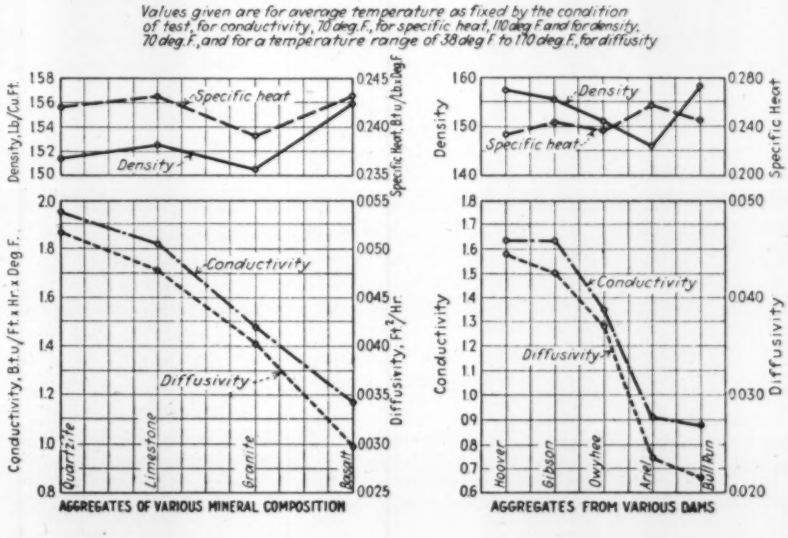
Results during a 30-day period, compared with 7- and 28-day moist-room test results, with different cements, gave three quite similar curves. The ratio of 28-day to eight-hour strength ranged from 3.2 to 3.9, average 3.60, while the ratio of seven-day to eight-hour strength ranged from 2.5 to 2.8, average 2.62. The eight-hour strengths were about 1,000 lb. per sq.in., the seven-day about 3,000, 28-day about 4,000. Mr. Patch concluded that, "While this method of concrete control is still in its infancy, the results so far indicate a prophetic accuracy practically as great as that obtained from the seven-day tests." He pointed out the far greater value of eight-hour results, permitting mix corrections to be made promptly, and the consequent saving in apparatus and test facilities.

Heat constants and aggregate

Elaborate measurements of conductivity, specific heat and the diffusion constant, made on concretes containing different aggregates, showed large differences in the properties that determine the rate of heat transfer and hence the rate of cooling of the dam concrete. C. S. Rippon and L. J. Snyder, of the Denver laboratory of the Bureau of Reclamation, described the test procedure.

The results shown by the curves plotted in Fig. 10 bring out the pronounced effect of the nature of the stone on heat transfer; quartz and limestone were the best, giving almost twice the rate of heat transfer as basalt, the poorest. Aggregates from five actual dams exhibited even larger differences. From the records of temperature changes in certain of these dams it was possible to compute values of the thermal properties, and these were found to check the measured values of Fig. 10 very closely.

Fig. 10—Thermal constants of concretes made with different aggregates. High rate of heat transfer is desirable for quick equalization of temperature differences. On this basis the aggregates of Hoover and Gibson dams are about twice as good as those of Ariel and Bull Run dams.


Values given are for average temperature as fixed by the condition of test, for conductivity, 70 deg. F., for specific heat, 110 deg. F. and for density, 70 deg. F., and for a temperature range of 38 deg. F. to 110 deg. F. for diffusity
Density, Lb./Cu. Ft.
Specific Heat, B.t.u./Lb./Deg. F.
Specific heat
Density
Conductivity, B.t.u./Ft. x Hr. x Deg. F.
Diffusivity, Ft.²/Hr.
Conductivity
Diffusivity
Quartzite
Limestone
Granite
Basalt
AGGREGATES OF VARIOUS MINERAL COMPOSITION
Hoover
Gibson
Owyhee
Ariel
Bull Run
AGGREGATES FROM VARIOUS DAMS

Cement studies

Investigations of cements of different composition, conducted by the University of California, Berkeley, under the direction of Prof. Raymond E. Davis, in cooperation with the U. S. Bureau of Reclamation and a number of cement companies, were planned to determine the influence of chemical composition, fineness of grinding and method of manufacture of cement upon heat of hydration, strength, volume change, and durability of mortar and concrete. The most important object was to develop a low-heat cement of satisfactory mechanical properties. More than 90 cements, with tests of more than 15,000 specimens, were included, about half of the cements being commercial brands and the others laboratory cements. As the studies are still in progress, only tentative conclusions were presented, among which are the following:

Tricalcium aluminate (C_3A) liberates most heat per unit of weight of the major compounds, largely during the early stage of hardening. Tricalcium silicate (C_3S) is next in heat generation, acting chiefly during secondary hardening, within the first day or week after hardening begins. Dicalcium silicate (C_2S) and tetracalcium alumino-ferrite (C_4AF) produce the least heat of hydration in long-continued action. Increased loss on ignition decreases the heat of hydration. The finer the cement the greater its heat of hydration. Increased water-cement ratio increases the heat generated.

The ratio of strength to heat generated is greater with extreme fineness, low tricalcium aluminate and high dicalcium silicate content.

Early strength depends principally on tricalcium silicate, while the gain in strength after the first week depends usually on dicalcium silicate. Cement high in the latter compound shows large gain of strength after 28 days.

Increased fineness increases the strength at late as well as early ages, nearly in proportion to increase in specific surface.

Curing one day at 70 deg. F. and then at 100 deg. F. until the time of test gives results not greatly different from those obtained under mass curing conditions (adiabatic curing).

Within the usual range of fineness, the finer the cement the less water is required to produce a concrete of fixed consistency. Specific surface is considered to be the most satisfactory measure of cement fineness, while the 200-mesh sieve does not give a satisfactory measure of fineness.

Engineering News-Record

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Bridges at San Francisco

Bridges were the center of interest in the San Francisco Bay region last week. On Sunday elaborate ceremonies were held to celebrate the official start of the Golden Gate Bridge, and on Tuesday the first bids were opened for the foundation work on the San Francisco-Oakland Bridge. Soon ground will be broken for the latter structure, with an imposing array of officialdom, and the work will be turned over formally to those who will do the actual construction work. Public officials enjoy and need not be denied their usual day of pointing with pride to the start of large construction operations; but the public, while liking the pageantry that is such an important part of the undertaking from the public official's viewpoint, is becoming more and more conscious of the fact that much of the credit belongs to the engineers who design and direct the construction. Ground-breaking ceremonies in large measure mark the end of the politicians' part in public-works projects, but the engineers' responsibility will not have been fulfilled until their planning stands in steel and stone. The test of their skill lies ahead in the coming demonstration of ability to execute as well as to conceive.

License Laws Follow Model

Bills providing for the registration of engineers have been introduced into the General Assembly of the state of Connecticut and into Congress for the District of Columbia. In both cases the proposed laws are notable for their close adherence to the model law drafted by representatives of the major engineering societies a few years ago and considerably revised last year. This is highly desirable, because the model law as it now stands is the result of much study directed toward producing a workable law that at the same time sets up reasonable minimum requirements for the practice of engineering. Sources of difficulty that have developed in existing laws have been avoided in the model law. Further, adoption of its standards in states where new laws are to be adopted or where existing laws are to be changed will help materially in bringing about regional and ultimately national uniformity. For the present the standards set by the model law may be too high for some parts of the country, but for Connecticut at least their parity with the New York requirements makes them desirable.

Hoover Dam Penstocks

Few steel-fabricating plants have started up with an initial "unfilled order" of 50,000 tons. Fewer still have been built at the site of the construction operation that is to comprise the first and probably the only customer. The plant being built at Hoover Dam for fabricating the penstocks has both these distinctions. In addition, the equipment being assembled for it is of such character and size as to be unusually notable. X-ray examination of welds has never been used as extensively as it must be used on these penstocks. The necessary equipment, which doubtless will be similar to that described in these pages three weeks ago, is therefore largely unprecedented. In this issue the bending roll required to shape the 3-in.-thick plates is described. There are not many rolls in the country that could do the work that this piece of equipment will be called upon to perform. Before many months a 150-ton-capacity cableway will be installed at the dam site to handle the fabricated penstock sections. This latter equipment is nearly five times larger than any previous installation. Further, some rather remarkable type of transportation must be devised to transport the 150-ton sections of penstock to the cableway from the fabricating plant a mile from the canyon rim. Thus it is again emphasized that, from beginning to end, Hoover Dam construction is destined, both by sheer size and unprecedented operation, to establish new benchmarks of progress of engineering development.

The Limit in Gas-Tax Steals

The suggestion of the governor of California that the entire state allotment of the gas-tax revenue for the next biennium might well be turned into the general fund represents the most extreme of current proposals to divert highway funds. Two years ago the present régime had a treasury surplus of about $30,000,000; it is now faced with an estimated deficit of $60,000,000 for the coming biennium. These stubborn figures speak more convincingly than words of the financial crisis faced by the administration and indicate the reason for the frantic urge to lay hands on any form of revenue. The state legislature, as is the case elsewhere, has found it difficult to curtail expenditures substantially, and every attempt to develop a new source of revenue is met by a united front of opposition in the field of industry affected. In this quandary the administration has suggested the bold stroke of taking *all* of the gas tax, which would be about sufficient to cover the estimated deficit. Meanwhile there would be an almost complete stoppage of road improvement. The situation presents a splendid opportunity for the forces of a united construction industry to lead a prompt and determined demand that gas-tax funds continue to be used only for the purpose for which the public has been led to believe they were collected.

Civic Health Recovered

It is reassuring to observe a gradual clearing of Chicago's administrative and financial muddle. Today some light is apparent in the murkiness of what had been an almost hopeless tax tangle. Supreme Court decisions having confounded the tax strikers, collections are beginning to catch up on the accumulated tax delinquencies, while R.F.C. funds are in the bank to build a needed pumping station, and plans are being drawn for a filter plant. With prospective liberalization of the Relief Act, work on hitherto stalled improvements, especially those of the Sanitary District, may soon be resumed. Work on the rapid-transit subway also is a possibility, but careful analysis of vehicular traffic suggests that elevated highways are more immediately necessary as logical and financially feasible solutions of the congestion to the west, southwest and northwest. Early slum clearance

in portions of the blighted ring around the downtown business center is highly probable. All of these possibilities find further support in the new consciousness of the state as to municipal needs and a willingness to help guide the Chicago metropolitan region along a road of sound, business-like reconstruction. Finally, the opening of the Illinois Waterway in June is expected to mark the beginning of a new era in low-cost transportation. These several factors are changing the present picture of stagnation sufficiently to give rise to the belief that Chicago is well on the way back to normal health. It is to be hoped that the death of Mayor Anton J. Cermak will not put a serious check upon the progress now being made.

Misunderstood Housing

HOW MUCH progress is made in housing development in the near future depends on how well the purpose and effect of better housing are understood. Many people think of slum clearance and housing as identical, and this unfortunate and unnecessary confusion is holding back action on housing. The two are quite distinct, and their difference should be clearly appreciated.

Housing aims to provide the improvement in living conditions that is needed by a large part of our people, whether the new quarters be placed in country, suburbs or city. It is not concerned with tearing down slums but proposes to put them out of business by providing more tolerable and more decent facilities. Slum clearance, on the other hand, is directed toward wiping out run-down city districts and replacing them with useful modern facilities, whether these be living quarters, business buildings or parks. It has only secondary interest in housing, as a possible device for accomplishing its purpose. If housing must wait on slum-clearance opportunities, or slum clearance on housing needs, we are in a bad way.

The fact is that every citizen is personally concerned in the central decay of cities. This decay, growing rapidly outward as sketched by Howard W. Green recently in an instructive compilation of data, is a menacing destruction of value and produces a large increase in community cost. The private citizen's interest as well as that of the community demands that its correction be taken in hand as rapidly as possible. But this is not necessarily so because of a need for housing. Improvement in sanitary conditions, reduction in crime and delinquency, increase of property values, all are adequate motives. Should the logic of the location dictate that good housing is wanted to replace an existing slum or blighted area, then housing may properly become associated with slum clearance. But this is a chance association, not a necessary one. Slums ought to be eradicated even though no additional housing is called for.

Similarly, better housing is demanded on grounds not primarily connected with the existence of slums. The case is well stated in a memorandum prepared in connection with a current housing exhibition conducted at the Architectural League in New York City. The architects who organized the exhibition, knowing that our national housing standard must be raised, point out that much of our present housing is objectionable, not as slums in the sense of being overcrowded and unsanitary, but as "mean, sordid and inadequate" provision for homes. Far more than the lowest-income third of the population is in need of rehousing, and large-scale effort is essential if such rehousing is to be provided.

It is of very present importance that the case for housing be understood clearly as something quite apart from the slum and blight problem. Already there has been serious delay in the promotion of sound housing, due to unintelligent or self-seeking association of the two problems; notably so in New York City, where the Hillside housing project was stalled by landlord pressure even after the R.F.C. had granted the project a loan. The same erroneous association stands in the way of clearing out slums, in New York as well as elsewhere.

What the architects of the housing exhibition have brought forward is therefore a timely reminder of broadly important facts. The exhibition itself should help to further right thinking on the matter. If the exhibition is also carried to other cities, it will do still more to promote general appreciation of the notorious fact that the home is among our most poorly designed, most inefficiently built and most perishable possessions, and that it needs to be modernized through wholesale housing reform.

Irrigation Refinancing

IRRIGATION, now enmeshed in financial problems of grave difficulty, appears to be making some progress toward their solution. The first major refinancing program among California irrigation districts has just been carried to completion, the Nevada Irrigation District having refunded $8,100,000 of outstanding bonds with a reduction in interest rate from 5½ to 4 per cent. Study of refinancing on a corresponding scale is going on in other districts. This development is of very definite interest here because irrigation is a major field of civil engineering and construction activity and therefore its present plight and its future have direct bearing on the engineer's work. Moreover, successful district refinancing will throw light on some important issues affecting the problems of federal reclamation.

The engineering and economic phases of irrigation are closely interdependent, and both transcend the legal phase in importance. Accordingly, the questions raised by the present financial stress find their answer in engineering analysis and economic appraisal rather than in a review of the law involved. Experience shows that a determination to enforce the obligations set by law to protect the security-holder often makes small headway and may result in more serious loss, while on the other hand a restudy of the physical characteristics of the case combined with careful consideration of the practical economics, based on knowledge of the people and conditions, will provide the basis for equitable negotiation. Such experience also proves that compromise is the key to irrigation refinancing.

Details of the financial readjustment depend on the individual problems of the district concerned. The existing financial load is a known quantity, as is the record of past experience in meeting the obligation. But appraisal of what the land can pay requires experience and rare judgment. The best way to obtain this, it appears, is through a blending of the knowledge of competent irrigation engineers, of fair-minded financial advisers and the district management, with enough legal advice to mark out the allowable limits of give and take.

NEWS OF THE WEEK

Contractor Qualifies for Work on Colorado River Aqueduct

Announcement that the contracting firm of Wenzel & Henock of Milwaukee, Wis., had obtained necessary surety bonds covering the $7,339,100 San Jacinto tunnel contract of the Colorado River aqueduct project was made Feb. 25 by F. E. Weymouth, general manager of the Metropolitan Water District of Southern California. Construction of that portion of the aqueduct system was to be started early in March. It is estimated that between 600 and 700 men will be employed on the tunnel construction during a six-year period.

Shelter Island Bridge Financing Declared Invalid

By decision of the Court of Appeals of New York State, the plan to connect Shelter Island in Long Island Sound with the mainland of Long Island by two suspension bridges (*ENR* April 16, 1931 p. 666 and October 15, 1931 p. 634) has been blocked. The court's opinion was that the board of county supervisors of Suffolk County was without power to construct the two bridges or to issue bonds to raise money for their construction inasmuch as it had not received the expres authority of the New York State legislature. The court held that the certificates of approval signed by the Chief of Engineers and the Secretary of War, by act of Congress, are conditioned upon the approval of the state legislature and therefore do not constitute sufficient authority to permit the bridge financing to go ahead. The decision is final since the Court of Appeals is the court of last resort in New York State.

New Bids Call for Steel Pipe for Denver Water Supply Line

On March 2 the Board of Water Commissioners of Denver, Colo., called for bids to be opened on March 13 for 36,000 ft. of new pipe ranging in diameter from 36 to 60 in. The estimated cost of the pipe in place is $291,000. The pipe is to be used to bring water from intakes on the Fraser River and on Jim Creek to a shaft at the west end of the pioneer Moffat tunnel and from the shaft through the tunnel past the high point in the tunnel.

During the latter part of 1932 the board called for bids on pipe for this aqueduct but the bids were not opened.

The pipe is all to be of ¾ in. plates manufactured into 30-ft. lengths, some to be prepared for welded joints and some for use with Dresser-type couplings. The 48-in. pipe is to be used from the west shaft of the tunnel to the apex, and for part of the Fraser River conduit. The remainder of this conduit will be 60-in. pipe. The 36-in. pipe is for the Jim Creek conduit.

Golden Gate Bridge Officially Started With Ceremonies

ATTENDED by a crowd of 200,000, ceremonies marking the official start of the Golden Gate bridge project were held Feb. 26 near the site of the San Francisco approach. Headed by the governor of the state, civic officials and directors of the district, the parade and fête marked the authorized beginning of this $35,000,000 development that will place a 4,200-ft. suspension span across the entrance to San Francisco Bay. Actual contracts were let some time ago and preliminaries to construction are already getting started.

Following a large parade the crowd assembled at the presideo, the federal military reservation at the south bridge head, and jammed the aviation field to witness the ground breaking. After the usual speeches and appropriate remarks from the officials, W. P. Filmer, president of the Golden Gate Bridge and Highway District, Mayor Rossi of San Francisco and Joseph B. Strauss, chief engineer, each turned over a shovel of earth with a gold spade that will be preserved as a museum piece. James Reed, general manager of the district, then set a bronze tablet commemorating the day.

The 4,200-ft. clear span of the Golden Gate bridge is three times the length of the Brooklyn bridge and 700 ft. longer than the George Washington Memorial bridge. The bridge proper will have a total length of 6,450 ft. as against 4,660 ft. for the George Washington bridge. The towers will be 740 ft. high above mean high water and will be the tallest bridge towers ever built. The main tower on the San Francisco end will have a total height of 884 ft. The minimum vertical clearance at the center will be 220 ft. above mean high water. Including approach roads the project will have a total length of 7 miles. The two main cables will be 36½ in. in diameter and will be 7,660 ft. long between anchorages. Cable sag at the center will be 475 ft., 150 ft. more than the George Washington bridge. The theoretical cable deflection at the span center is 10.65 ft.

Golden Gate, site of the bridge begun formally on Feb. 26. At the point in the foreground is the trestle built out to the site of the south pier.

in a vertical direction and 21.25 ft. horizontal.

Preliminary work now underway includes excavation on the north approach to facilitate start on foundations and trestle construction to reach the site of the main pier on the south end. In addition, arrangements are being completed by foundation contractors for the coming concreting operations. Main foundation contracts are held by Pacific Bridge Co., $2,935,000 for the two main piers, and Barrett and Hilp, $1,859,854 for the anchorages and piers for approach spans.

Force Account Work on Tunnel for Coast Aqueduct Opposed

Bids were opened Feb. 28 by the Metropolitan Water District of Southern California for about $500,000 worth of equipment for construction use on the Colorado River aqueduct. The bids were for sixteen air compressors, sixteen storage battery locomotives, eight motor generator sets, sixteen air receivers, sixteen mucking machines, eight power shovels, 136 dump cars and sixteen flat cars. The equipment is to be used on the Coachella tunnel division of the aqueduct where the district plans to do the work by force account.

The decision of the Metropolitan Water District of Southern California to go ahead with part of its Colorado River aqueduct tunnel construction on a force account basis and to purchase nearly $1,000,000 worth of construction equipment is in gross disregard of local taxpayers' interests and the interests of taxpayers throughout the country, according to a statement made by E. J. Harding, managing director, Associated General Contractors of America. Mr. Harding states, "Federal money, supplied through the R.F.C., was not intended to be used for the purpose of putting local governmental agencies into business at the expense of private construction firms. If the announced plan of the Metropolitan Water Board is carried out, there will result an enormous waste of public funds through the setting up of a huge force-account day labor organization to be employed in constructing vital sections of the $220,000,000 Southern California aqueduct. It will mean that the work will proceed with no guarantee of cost, without bids from responsible firms and without adequate check of performance. In purchasing such equipment and entering upon a construction business venture of this magnitude, the Metropolitan Water Board is departing from its primary function of furnishing a water supply and is definitely engaging in competition with responsible established construction firms which have lying idle in their yards equipment similar to that which the district intends to buy."

Similar protests have been voiced by F. J. Connolly, manager for the local chapter of the A.G.C. in Los Angeles. Mr. Connolly called upon the Metropolitan Water District to recognize the fact that there are unemployed business organizations in the community who are called upon to pay taxes and support the district just as there are unemployed individuals and that the district should not go into competition with them. On the San Jacinto tunnel the contractor bid $1,000,000 below the engineer's estimate.

Work Starts on Deep Piers for Bridge at New Orleans

Encouraging progress is being made on the New Orleans Belt bridge, according to a report to the Reconstruction Finance Corporation by John F. Coleman a member of its board of engineers.

As a first step toward sinking the foundation of one of the piers of the main span a willow mattress 450x250 ft. has been woven and is ready for sinking in 70 ft. of water at the bridge site. Through this mattress a cofferdam of steel sheet piling, 121 ft. in diameter, will be sunk to a depth of 107 ft. The foundations for the pier will then be built within this cofferdam following a method similar to that employed in sinking the piers for the Suisun Bay bridge in California (*ENR*, Jan. 30, 1930, p. 174).

In order to handle the heavy steel sheet piling of which the cofferdam is to be built temporary staging is being erected on 120-ft. wooden piles brought in from Oregon.

Contractors To Bid on Financing of Seattle Power Development

A plan calling for contractors who bid on extensions to Seattle's power and light plant to arrange for financing the work has been approved by the city council's utilities committee. Offers received from contractors will be compared with those received from investment bankers and with the proposals of the directors of the R.F.C.

The program contemplates completion of the Diablo power house on the Skagit River, the installation of generating machinery already purchased, construction of a new transmission line to the Gorge Creek plant and retirement of about $1,000,000 warrants issued for want of cash to meet installments on machinery and other purchases. Bidders will be asked to take city light bonds at par for the new work and to furnish enough cash on additional bonds to retire the warrants. The R.F.C. offered to advance $1,625,000 at 6 per cent to complete the new construction and investment houses made a similar offer provided an audit showed the light department accounts to be in a satisfactory condition.

Contractor To Arrange Financing of Proposed Bridge at Omaha

One bid was received by the Omaha-Council Bluffs Missouri River Bridge Trustees when bids on a proposed bridge from Omaha to Council Bluffs were opened on March 1. The project has been under consideration for some time but the trustees have been unable to arrange satisfactory financing. Recently the Reconstruction Finance Corporation was approached but was unwilling to make a loan because of the nearness of a toll bridge carrying the tracks of the street railway company. As a result, the trustees recently called for bids on a basis which required the bidder to agree to take the trustees' bonds in payment for the work.

The bid received was from the Great Lakes Dredge & Dock Co., Chicago. That company offered to take $1,786,000 of the trustees' bonds at par for the bridge work and a sufficient amount of bonds at 95 to cover right-of-way costs, engineering, contingencies, etc.

Under the provisions of the call for bids, the bidder has twenty days after notice of award of contract in which to sign the contract and put up a $500,000 performance bond and the work must be completed within 300 days after the contract is let. The contractor put up a bid bond of $50,000.

The Omaha-Council Bluffs Missouri River Bridge Trustees form a public body set up to build a bridge as a toll structure to become a free bridge as soon as the bonds are paid off.

Robinson & Steinman, New York, are the consulting engineers.

Engineers Put on 30-hr. Week

A city ordinance decreasing pay and working hours for 386 men in the technical division of the bureau of engineering, Los Angeles, Calif., to prevent the laying off of 86 men, was adopted Feb. 28 by the Los Angeles city council. The measure became effective Mar. 1 as an emergency matter. The 386 men will be put on a 30-hr. week and their pay will be decreased to 30 per cent below the base. They have been working on a 5-day week at 21 per cent below the base pay. The saving in salaries will be approximately $2,400 per month.

Washington Notes

By Paul Wooton
Washington Correspondent

OPERATION of Muscle Shoals by the Bureau of Reclamation is being urged in the event the Norris bill is approved. It is pointed out that the Bureau of Reclamation has been constructing and operating hydro-electric plants for 25 years. It is the only federal bureau that has operated such plants commercially and done it on a paying basis and without controversy with the consumers who were municipalities, farmers, mining companies, and other corporations. Such plants include one on the Salt River near Phoenix, Arizona; Colorado River near Yuma, Arizona; and the Snake River near American Falls, Idaho.

All of the plants operated by the bureau were built primarily to furnish power for use in constructing irrigation works or for pumping irrigation water, and excess power was sold to the towns and farmers on the project.

Twenty hydro-electric power plants on 11 of the 29 federal reclamation projects were in operation during the fiscal year 1931-32. These plants have a total installed generator capacity of 102,550 kw., and they generated 331,793,500 kw.-hr. of energy, of which 21 per cent was utilized for irrigation and drainage pumping, 65.4 per cent was sold for commercial and industrial uses, and the remainder, or 13.6 per cent, was used for miscellaneous purposes and consumed by losses. Eleven of these plants were operated directly by the water users, and nine, having a total installed generating capacity of 31,500 kw., were operated by the government.

Metropolitan Sewer District Proposed at Atlanta, Georgia

Creation of a Metropolitan Sewer District to include Atlanta, Ga., and adjoining communities, is provided for in a bill passed recently by the state senate in Georgia. Construction of a sewer system would be financed by the issuance of revenue bonds based on service charges of 20c. per month for each fixture attached to the system. If the bill is passed, it is hoped to obtain funds to finance part of the work from the R.F.C.

The bill would empower the board of trustees with the right of eminent domain to condemn property for rights of way and would give the board the power to buy existing sewer systems in the district.

Colorado Spring Gets Rights To Supplement Water Supply

After a long-drawn legal battle, the city of Colorado Springs on March 1 was granted the right to divert 4 sec.-ft. of water from Fountain valley in Pueblo County to Catamount Creek. The city proposes to build a reservoir in the valley of Catamount Creek. The ruling granted by District Judge Samuel Trimble permits the city to divert 4 sec.-ft. from June 15 to Sept. 15 and during that period it must relinquish not to exceed 2.5 sec.-ft. of the ditch flow to Green Mountain Falls and 0.8 sec.-ft. for the rest of the year. Green Mountain Falls will be permitted to divert 6 acre-ft. during the year for storage. The Eder and Whipple ditches from which the water will be diverted have a flow of 6.1 sec.-ft.

Loans Sought for Toll Road and Water-Filtration Plant

A loan of $13,000,000 from the R.F.C. is sought by the Westchester County Park Commission, New York, for financing the proposed Pelham-Port Chester highway. A toll of 25c. per vehicle is planned until the loan is paid off. The road would roughly parallel the Boston Post Road.

Preliminary application has been made by Michigan City, Ind., to the R.F.C. for $300,000 with which to build a 5-m.g.d. filtration plant and low lift pumps. Design of the plant is now under way. The Michigan City waterworks is handled by a commission empowered to sell water within or outside the city, including sale to the city of water for fire protection for which a hydrant rental is charged.

Belleville, Ill., is having a survey and report made as to the relative merits of continuing to buy water from the East St. Louis Water Company or building a plant of its own. In the latter case application would be made for a R.F.C. loan.

Batavia, N. Y., which has under consideration the construction of a gravity water supply with funds from the Reconstruction Finance Corporation, has received an offer from a group of Buffalo business men to build the proposed plant with private funds. Should the R.F.C. loan plan fail to materialize, the proposition of the Buffalo men may be considered.

Bids Made for Piers of San Francisco-Oakland Bay Bridge

THREE formal bids and one informal bid were received by the California Toll Bridge Authority for the piers to form the substructure of the west bay crossing of the San Francisco-Oakland bridge when the bids were opened on Feb. 28. The low bidder, as noted last week, was the Transbay Construction Co., Financial Center Building, San Francisco, with a bid of $6,957,100. The other bidders were the Silas Mason Co., San Francisco, $8,311,653, and Bridge Builders, Inc., San Francisco, $7,278,014. An informal bid by Benjamin Walter & Associates, San Francisco, was $7,929,768.

The Transbay Construction Co. is made up of Charles F. Swigert, of the Pacific Bridge Co., Portland, Ore., contractors for the foundations of the Golden Gate bridge; J. A. McEachern, San Francisco; Chas. A. Shea of J. F. Shea Co., Portland; Felix Kahn of MacDonald & Kahn Co., San Francisco; and H. W. Morrison of Morrison-Knudson Co., of Boise, Idaho.

Bid opening on other parts of the bridge were scheduled for March 2, 6, 7 and 8. Doubtless all will be postponed. The March 2 date already has been advanced to March 10.

Plans Completed for Bridges To Be Built at Richmond, Va.

Plans for a new bridge over the James River at Richmond, Va., and for the reconstruction of the two viaducts over Shockoe Valley have been completed by the Richmond Bridge Corp. and bids are to be called soon. The bridge construction program, formerly a municipal project, has been under consideration for some time. Actual construction was made possible in late November through the approval of an R.F.C. loan of $1,700,000 to the Richmond Bridge Corporation, a public service company.

The principal structure is the James River Bridge, a structure of sixteen reinforced-concrete arch spans of 197 ft. having a height of about 80 ft. above the river. With approaches, this bridge will have a length of 3,800 ft. It will be located to the west of the existing bridge and U. S. Route No. 1 which now crosses by the old bridge will be rerouted over the new one thus taking it out of the congested commercial and industrial districts of the city. The new bridge will be at a higher level spanning the railroad tracks on both banks of the river and providing better approach grades for the highway.

The two viaducts are to be of reinforced concrete with spans of about 80 ft. and a height of 80 ft. above the valley floor. The roadway of each will be 30 ft. wide with provision for car track in the middle and flanked by a 4 ft. sidewalk.

Allen J. Saville, Inc., is engineer for the bridge corporation with A. C. Janni, New York, and Lee, Smith & Vandervoort, Inc., of Richmond, as consultants.

Plans will be issued to bidders on March 10, returnable March 31.

Registration Sought in Missouri for Architects and Engineers

A bill providing for the regulation of the practice of architecture and professional engineering was introduced to the Senate of the State of Missouri on Feb. 21. The bill has the endorsement of prominent members of both professions in St. Louis. It was prepared by a committee appointed by the St. Louis Chapter, American Institute of Architects and the Joint Council of the Associated Engineering Societies of St. Louis.

In form, the bill followed closely the model registration law approved by the major engineering societies but has been modified to include architects.

Construction of Highway Bridge Over Spillway Channel Deferred

Construction of the highway bridge over the Bonnet Carre spillway will be deferred until further federal-aid funds become available after July 1, according to A. P. Tugwell, chairman of the Louisiana Highway Commission. The commission, he said, still adheres to its plan to construct a 40 ft. wide concrete structure rather than the 30 ft. creosoted timber span on the basis of which the federal government awarded damages. On Oct. 2, 1932, the commission received $820,501 from the government representing $506,651 for the cost of a creosoted timber bridge to span the spillway in place of the existing highway, $234,422 for maintenance of such a span, and $79,408 to reimburse the state for expenditures made on the right of way and construction within confines of the spillway of the Hammond-New Orleans lakeshore route.

Two Engineers in California Convicted Under Registration Act

Two convictions for violation of the civil engineer's registration act of California were obtained recently by the State Board of Registration for Civil Engineers. In one case, Preston M. Jones of Los Angeles, having allowed his registration to lapse as of June 30, 1932, prepared structural plans for the J. C. Penny Company's store at Riverside and filed them with the building department there. The plans were returned because they had not been prepared by a registered civil engineer and the registration board was notified. As a result, a complaint was filed and Mr. Jones was called before the municipal court of Los Angeles where on Feb. 7 he entered a plea of guilty and was sentenced to thirty days in jail. The sentence was suspended upon the condition that the defendant renew his certificate and would not again violate the act.

Vern Ostendorf of Colton, Calif., as a result of his assuming responsible charge of design and construction of the grandstand at the Compton dog track, was called before the Justice of Peace at Compton for practicing civil engineering without being registered. He entered a plea of guilty and was fined $1 and sentenced to serve fifty days in the county jail. His sentence also was suspended on the promise of good behavior and compliance with the law.

Work Starts on Park Project to Provide Unemployment Relief

Work has been begun on the 1,840-acre marine park development in Brooklyn, New York, as one of the unemployment relief projects for the New York metropolitan district. When completed, according to the present plan the park will cost in the neighborhood of $40,000,000. Land for the park was acquired ten years ago but work of developing it has been held up.

Engineers Urged to Seek Out Local Unemployment Agencies

Because of the many applications received by the Engineers National Relief Fund Committee for information as to where temporary employment or relief can be obtained, the committee has sent out an announcement calling attention to the fact that practically every state, county and city has raised or appropriated funds to provide for the relief of unemployed. Where no local relief committee has been set up by engineers, the national committee recommends that engineers in need of assistance get in touch with the officers of local sections of the national engineering societies, officers of local engineers clubs, the city engineer or the county engineer. These men will be able, generally, to give advice as to how relief can be obtained from local agencies.

Taxing Rights in Boulder City Upheld by Federal District Court

The right of the state of Nevada to tax property in the exercise of its civil authority in Boulder City and in the Hoover Dam reservation, with the exception of the permanent works, has been upheld by the Federal District Court. The petition of Six Companies, Inc., for a permanent injunction to restrain the state from the collection of taxes in the reservation was dismissed by Judge Frank H. Norcross, who wrote the decision. At the same time another ruling declared that the Nevada law which prohibits the use of gasoline engines underground was intended to apply to mining and was not applicable to construction operations on the project.

The first decision held that the reservation had been created for a temporary purpose only and therefore did not come under a Nevada law, since repealed, that gave the Federal government jurisdiction over the territory. The project act, in the opinion of the court, "clearly discloses that the dam and incidental works therein referred to are of permanent character and specifically provides the title to said dam, reservoir, plant and incidental works shall forever remain in the United States. It is clear that the state does not contemplate a ceding of jurisdiction over a site the use of which is not only temporary but incidental to some other purpose."

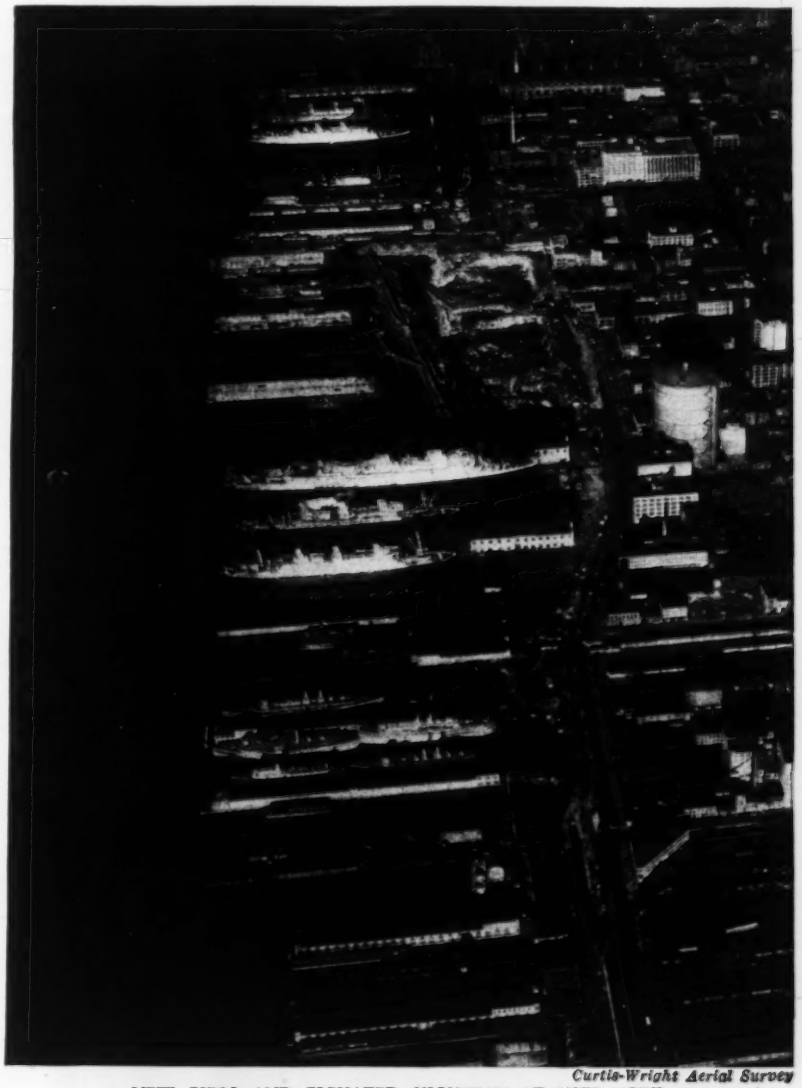
Contention of the Six Companies, Inc., that it is an "instrumentality of government" resulted in the court's opinion that "it does not exercise governmental functions. It undertakes to construct, according to plans and specifications adopted by officials of the government. It is organized for that and similar purposes and its primary object is to comply with the condition of the contracts for the profit made in so complying."

No New Unemployment Among Cincinnati Engineers

A heartening note as to unemployed engineers comes from the welfare committee of the Engineers' Club of Cincinnati which states that no additions to the list of unemployed have been received in the last several months. Some inquiries for men have been received and engineers have been placed. A few agency and sales positions have been filled with reasonably satisfactory results. While doing an enormous amount of discouraging work attempting to unearth openings the committee feels that the indications are favorable, that the tide of unemployment has ceased to rise and that more substantial inquiries for help are close at hand, with a slow but certain return to normal conditions.

Plan to Build Incinerators for Detroit with R.F.C. Loan

Construction of Detroit's four proposed garbage and refuse incinerators through a private corporation financed by an R.F.C. loan is proposed in a bill introduced into the House of Representatives in Washington. When Detroit called for bids for disposal of its garbage and refuse on a tonnage basis in January, no bids were received. As the city is unable to put up securities for a direct R.F.C. loan, it is proposed that the loan be made to a private corporation and that that corporation build the incinerators, estimated to cost $1,500,000, and finance their operation and repayment of the loan out of charges against the city on a tonnage basis for garbage and refuse disposed of.



Curtis-Wright Aerial Survey

NEW PIERS AND ELEVATED HIGHWAY AT NEW YORK

Three 1,100-ft. steamship piers are under construction on the Hudson River waterfront above 45th St., New York. The outer ends of the piers are complete except for the superstructure. At the land end, where the slips cut back into the island, removal of the old piers and bulkheads and rock excavation to give a 46-ft. depth in the slips is being carried on inside a large cellular cofferdam. In the marginal street, near the top and bottom of the picture, may be seen the temporary ramps of the partly completed West Side elevated highway. Street changes necessitated by the new pier construction have delayed work on this highway between 38th and 59th streets. Foundations are in place for the section from the 38th St. ramp to 46th St.

Tall Building for Mexico City

The final details have been completed for Mexico City's first skyscraper, a 12-story building of steel, concrete and various colored marbles to cost 2,500,000 pesos. The building is to be the headquarters of La National Life Insurance Co.

Large-Scale Housing Proposals Assembled in Extensive Exhibit

A housing exhibit, forming a part of the 1933 Architectural League show in New York, portrays by means of displays of photographs and data the comparative results obtained by large-scale community building and the usual small-scale speculative operation. Some of the plans shown are for projects still in the design and promotional stage. Most of these are designed to rehabilitate blighted areas and in addition have the emergency purpose of providing employment and self-liquidating investment for national funds. The projects illustrated, from Cleveland, Detroit, Philadelphia, Newark and New York, are accompanied by air photographs showing the condition that the project proposes to remedy. A section on European housing illustrates what has been done since the war in England, Germany, Holland, France, Switzerland, Russia and Austria to create low-rental buildings. Some three and a half million homes have been constructed in these countries since the war through governmental control and investment, and in many cases through outright subsidy as well. The total investment is something over $7,000,000,000.

The ten existing American developments that are exhibited represent an investment of $31,000,000. Among these are the war housing for industrial workers built by the U. S. Government at Bridgeport, Conn.; Mariemont, the planned satellite suburb of Cincinnati; Chatham Village, the community for white-collar workers recently completed by the Buhl Foundation in Pittsburgh; and the two City Housing Corp. projects, Sunnyside in Queens, and Radburn, N. J. Apartment developments include Mr. Rockefeller's cooperative Paul Lawrence Dunbar apartments for negroes in Harlem; the Michigan Boulevard apartments in Chicago, also for negroes, constructed by the Julius Rosenwald Fund; and the Phipps Garden apartments in Queens built by the Society of Phipps Houses. Two tax-exempt apartments that are exhibited, built under the New York State housing law, are the Brooklyn Garden apartments and the Amalgamated dwellings in Grand St., Manhattan.

Among the developments exhibited but not yet built are: Prudential Life Insurance Co. in Newark, N. J. (contract let last week); Joseph L. Weinberg and Conrad & Teare, architects, for a location at Central and Scoville Aves., Cleveland; Cleveland Chamber of Commerce for a location adjoining the central business district (Walter R. McCornack, architect); Union of Full Fashioned Hosiery Workers in Philadelphia (Kastner & Stonorov, architects); and one promoted by Sukert & Gordner, architects, in Detroit. It is proposed to take the exhibit to other cities.

Brief News

RECONSTRUCTION OF TWO PIPE LINES between Landsburg and Lake Youngs for the municipal water system of Seattle, Wash., has been recommended to the city council by its utilities committee. The cost of the work is estimated to be $700,000. O. A. Rohlfs, water superintendent, has asked that bids be taken on various kinds of pipe lines in order to determine which will be the most economical in the long run.

CONTROVERSY OVER THE LEGALITY OF ROAD WORK which has held up payment of the contract for a long time in Clark County, Indiana, has been settled by a special act recently signed by the Governor legalizing the payment to be made. During a drought a few years ago the contracts were rushed through in order to provide relief work for farmers, the county authorizing road construction and repair work to the amount of $30,000 before actual appropriations were made.

A MODEL OF HOOVER DAM 17 ft. long and 12 ft. high is being constructed in the Denver office of the Bureau of Reclamation for the Century of Progress exposition to be held in Chicago next summer. The model is being built to a scale of 1 in. equals 30 ft., both horizontal and vertical, and all features of the dam are accurately represented. The reservoir will be filled with water so that the power plant, outlet works and discharge through the spillway can be operated in miniature.

A LONG-STANDING CONTROVERSY over water rights affecting the water supply of Los Angeles, Calif., was brought to a close late in January when negotiations were completed for the purchase by the city of the Fred Eaton ranch in Long Valley in the Mona Basin as an adjunct to the city water supply. The 12,000 acre ranch was purchased for $650,000. A few years ago it was offered to the city at about $2,000,000. The ranch constitutes the largest single ranch purchased by the city in its program of buying up ranches in Owens and Long Valley for water supply.

SUITS OVER $10,000,000 OF HIGHWAY CONTRACTS begun in 1930 and 1931 in the state of Arkansas have reached the stage where testimony has been received by the Special Master in the first suit to be taken up. The contracts for the work in question have been declared to be illegal and the present suits are to determine what payments the contractors are entitled to under the contract. The state supreme court has held that the contractor is entitled to a reasonable sum for his work since he was allowed by the state to complete the work.

ELIMINATION OF SEWAGE POLLUTION in Lake Erie and the Niagara River at Buffalo, N. Y., is proposed in a plan submitted to the city council by Frederick K. Wing, head of the Frederick K. Wing Co., consulting engineers, Buffalo, N. Y. The council already has before it a plan known as the Gascoigne-Tolles plan which calls for a project entailing the expenditure of $23,000,000 while the Wing plan proposes an expenditure of about $9,000,000. The Gascoigne-Tolles plan provides for two disposal plants while the Wing plan provides for only one disposal plant.

SOCIETY CALENDAR

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual meeting, Chicago, March 13-15.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Chicago, June 27-30.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Chicago, June 26-30.

AMERICAN WATER WORKS ASSOCIATION, annual meeting, Chicago, June 12-16.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Chicago, June 27-30.

ENGINEERS WEEK, Century of Progress Exposition, Chicago, June 25-30.

FOUR STATE SECTION, American Water Works Association, will meet in Washington, April 27-28.

NEW ENGLAND SEWAGE WORKS ASSOCIATION will hold its spring meeting at the Blackstone Hotel, Woonsocket, R. I., on May 1.

BUFFALO SECTION, New York State Association of Highway Engineers, at a meeting held on Feb. 27, adopted a resolution calling on the state legislature to increase the appropriation for state highway construction.

THE ENGINEERS CLUB OF MINNEAPOLIS, at a meeting held Feb. 20 adopted a report of its special committee on the Reconstruction Finance Corporation recommending that the provisions of the Relief Act be liberalized to foster the construction of needed public works.

Personal

R. P. LONG has been appointed sanitary engineer of Dallas County, Dallas, Texas.

DANA M. WOOD, for many years associated with the Stone & Webster Engineering Corporation as consultant in hydraulic engineering, has established an office for private practice at 31 Milk Street, Boston, Mass.

ROY G. MCGLONE, chief engineer of the Long Beach, Calif., Harbor Department since 1925, has tendered his resignation to the Long Beach Harbor Commission. The commission has accepted the resignation and has instructed the Port Manager to fix its effective date after arranging a leave of absence for Mr. McGlone.

SPENCER D. DOWNING, Lima, Ohio, has been appointed division engineer of Division 11 of the Ohio State Highway Department to succeed CHARLES ASH, resigned. Mr. Downing is a graduate of Ohio State University in the class of 1916. Formerly he was with the Baltimore and Ohio Railroad and also in private practice.

FRANK W. DONOVAN, assistant district engineer, New York State department of public works, Syracuse, N. Y., has been appointed district engineer at Birmingham, N. Y., and ANDREW R. MULLIGAN, assistant engineer, New York State department of public works, has been named assistant district engineer, of Syracuse district to succeed him.

FRANK A. WELLER, Los Angeles, Calif., construction engineer, has been appointed a tunnel superintendent on the Coachella division of the Colorado River aqueduct project of the Metropolitan Water District of Southern California. Mr. Weller, who for the past 25 years has specialized in

railroad and tunnel work, will be in charge of the district's construction camp in Berdoo Canyon, in the Little San Bernardino mountains, on the 18-mile East Coachella tunnel.

Obituary

EDWIN R. BOWIE, engineer of the Colorado highway department, and graduate of the Colorado School of Mines, died Feb. 27.

EDWARD B. GUTHRIE, 83 years of age, former city engineer of Buffalo, N. Y., and at one time chief engineer of the Buffalo Grade Crossing Commission, was killed Feb. 28, by being struck by an automobile. Mr. Guthrie was born in Putnam, Ohio, but has been a resident of Buffalo since 1851. He was graduated in 1871, from Yale University and subsequently took up postgraduate work at Renssalaer Polytechnic Institute but left the latter institution to accept an engineering job with the Buffalo and Jamestown R.R. In 1874, he became assistant city engineer and in 1896, became city engineer. He was chief engineer of the Buffalo Grade Crossing Commission at the time of his retirement in 1928.

FRANK L. M. TALBOT, retired contractor, died at Glen Ridge, N. J., on March 6, age 71 years. Mr. Talbot was a native of Lubec, Maine, and while a young man went West on railroad construction work, ultimately becoming assistant superintendent for the Northern Pacific Railroad Co. on building and bridge construction. In 1894 Mr. Talbot returned to the East and was with Arthur McMullen & Co. from 1897 to 1900 on the Holyoke Dam. After about five years on grain elevator work in the Central West Mr. Talbot again returned to the East and was with the McMullen Co. on bridge and tunnel work. Subsequently, he formed the F. M. Talbot Co. which firm built the Tunkhannock viaduct for the Lackawanna Railroad, also the Martin's Creek viaduct, then the two largest concrete viaducts in the world.

LYMAN E. BISHOP, consulting hydraulic engineer, Denver, Colo., died on March 6 of a self-inflicted gunshot wound. Mr. Bishop was born in Des Moines, Iowa, 49 years ago and graduated as a civil engineer from the University of Colorado in 1908. Previous to graduation he had worked as a rodman and instrument man on irrigation work and following graduation he reentered irrigation work and has specialized in that field since that time, partly as an engineer in the employ of various firms and partly as a consulting engineer. From September, 1914, to November, 1915, he was employed in the U. S. Reclamation Service and from May, 1915, to May, 1917, he acted as deputy state engineer of Colorado. In 1929 Mr. Bishop went to Russia as a consulting engineer to the general cotton committee of the Soviet Government, remaining there two years as a consultant on irrigation work.

Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly Average Mar., 1932	Four Weeks	Week Mar. 9 1933
Federal government	$2,667	$2,423	$5,036
State and municipal	7,463	3,892	3,587
Total public	$10,130	$6,315	$8,623
Total private	7,893	7,221	9,455
Week's total	$18,023	$13,536	$18,078

Cumulative to date:

1932	$215,441
1933	184,575

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

	Weekly Average Mar., 1932	Four Weeks	Week Mar. 4, 1933
R.F.C. loans made	.....	$1,200	$400
New capital issues	$17,200	3,700	400
Total	$17,200	$4,900	$800

Cumulative to date:

1932	$180,200
1933	62,100

R.F.C. self-liquidating loans:

Approved current week	$751
Approved to date (including 1932)	174,104
Actual loans made (including 1932)	22,429

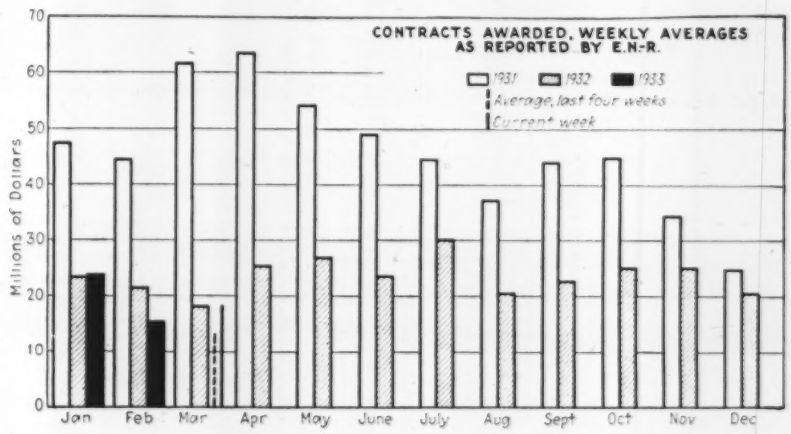
ENR Cost and Volume Index

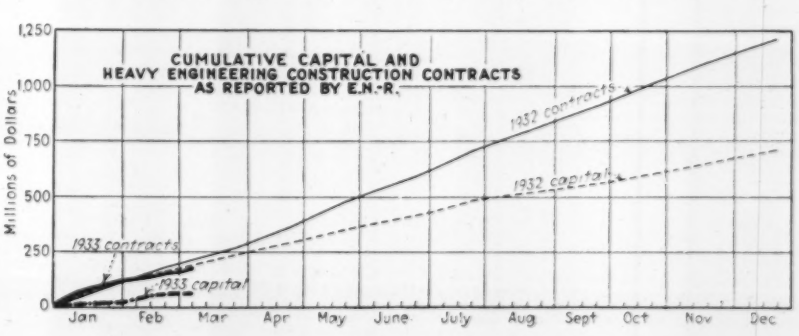
E.N.-R. Cost		E.N.-R. Volume	
March, 1933	**158.44**	**February, 1933**	**82**
February, 1933	159.30	January, 1933	129
March, 1932	157.24	February, 1932	105
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 Average	100		

Engineering Contracts and Capital

BOOSTED BY the highest weekly total reported in private contract lettings in seven months, heavy engineering construction contracts for last week total $18,078,000. The average of contracts let during the past four weeks is $13,536,000, as compared with $18,023,000 a year ago. Contracts let to date this year total $184,575,000, as compared with $215,441,000 for the same period of 1932. During the last week private awards amounted to $9,455,000, the highest week since last July. The average of private lettings the past four weeks was $7,221,000. In the private field contracts were let last week for an irrigation dam and spillway on the Pecos River in Texas, $3,500,000; for industrial buildings totaling $1,873,000 and for commercial buildings aggregating $3,637,000. Public works awards for the past week amounted to $8,823,000, as compared with a four-week average of $6,315,000. Of the total amount of public works, federal awards accounted for $5,036,000, the heaviest in four weeks. State and municipal lettings totaled $3,587,000, a decline from the last two weeks. Highway lettings were above the average of the past month with $3,199,000. The largest public award reported was that for the new post-office at Columbus, Ohio, $1,279,000.

New productive capital issues reported during the week were unusually small, amounting to $400,000 of regular issues and $360,000 representing an advance to the Middle Rio Grande Conservancy District on a previously committed loan agreement by the Reconstruction Finance Corp. The R.F.C. agreed to finance eight more self-liquidating projects totaling $750,500. These figures bring the total commitments of the R.F.C. to $174,103,850, and the amount actually advanced for construction to $22,429,000.





Construction Equipment and Materials

Heavy-Duty Drag Scraper

The Crescent drag scraper, manufactured by Sauerman Bros., Inc., Chicago, Ill., is now being made in a 12-yd. size, characterized by light weight. The new Crescent is of welded construction and has a cast-steel bail. Lip and end castings are of heat-treated alloy steel, providing great strength and resistance to crystallization.

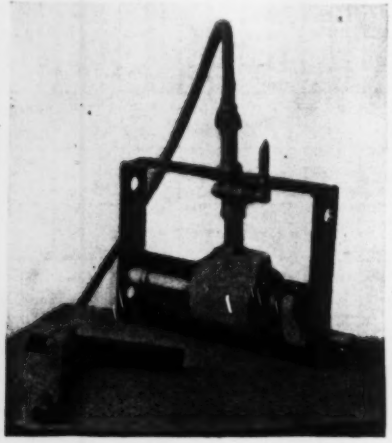
"Crescent" drag scraper has 12-yd. capacity.

Tapered tooth sockets are cast integral with the lip, and renewable tooth points are fitted into these sockets. Each tooth point is held in place by a single bolt, the head embedded in the tooth casting. The tooth has an octagonal tang, permitting it to be inserted with the direction of face at the most advantageous angle.

Universal Holder-On

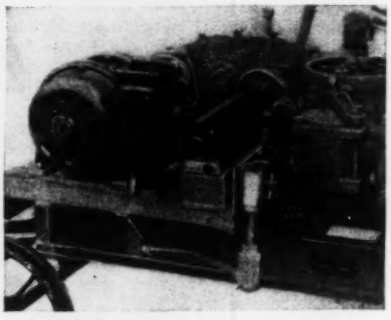
For backing up rivets in corners and other more or less inaccessible places a new air-jamb or holder-on with telescopic adjustment and a revolving offset head has been devised by F. J. LeMieux, 1542 West Jackson Blvd., Chicago. It consists of a cylindrical air chamber with a 3 in. plunger. The offset head can be changed from offset to straight. When a rivet head is being held by the offset the pressure is exerted directly through the offset and none straight since the pilot head has a shorter shank and does not reach bottom. This feature prevents heating and burning of the leather on the plunger even with continuous riveting. The plunger automatically returns on release of the air as a heavy spring is provided back of the plunger. On the side is a port hole which gives a warning whistle if the length adjustment is not made when the plunger has made a full stroke and does not hold the rivet tight. Tail pieces of different length are provided or a long adjustment can be made with a piece of pipe. The holder-on weighs 12 lb., is 7 in. long and has been used to hold rivets up to 1⅛ in. in diameter.

Air-jamb to hold rivets in close quarters.



New Electrical Control For Portable Sludge Pump

To meet the need of a large municipality for operating a portable sludge pump in outdoor service on either 220 or 440 volt electric current, the Chain Belt Co., Milwaukee, Wis., have made a new application of electrical controls to one of their Rex sludge pumps. Turning a handle provides proper connection with overload protection for either voltage. Three control units are used, a drum switch for proper reconnection of the motor leads, an overload circuit breaking switch, and an oil-immersed safety power switch. The first two units are enclosed in the same housing as the motor and their operating handles are accessible through the small door in the housing. The oil-immersed switch is mounted on the pump frame for "on-off" service.



Control device permits operation of motor on either 220 or 440 volt current.

Business Notes

INTERCONTINENTAL PIPE & MINING CO., INC., has announced that its name has been changed to IPAMCO PIPE CORP. Its New York address has been changed to 60 East 42d St.

NELSON E. CHANCE, formerly district manager of the Houston office of the Brown Instrument Co., has been appointed assistant sales manager with headquarters at Philadelphia.

MOHAWK ASPHALT HEATER CO., for many years located at Schenectady, N. Y., announces the removal of its factory and general offices to a new, modern building at Frankfort, N. Y., on or about March 1.

A. M. BYERS CO. announces that M. J. Czarniecki has been appointed general manager of tubular sales. The company has manufactured principally wrought iron tubular goods but has more recently broadened its wrought iron products to include plates, sheets, structurals, rivets, forging iron and welding fittings.

New Equipment in Brief

Tape Rule. The Lufkin Rule Co., Saginaw, Mich., has announced the all-stainless Crescent tape rule No. S-696. In this new flexible-rigid 6-ft. tape rule, stainless steel is used for both the blade and the case.

Traffic-Line Paint. A new paint for marking traffic zones which is characterized by rapid drying and durability under traffic, known as "Romark," has been announced by the Glidden Co., Cleveland, Ohio.

Roller Chain. Link Belt Co., Indianapolis, Ind., has announced a new roller chain known as the "Silverlink" with side bars especially treated to assist in resisting corrosion. The pins are of case-hardened nickel steel. Rollers are of heat-treated alloy steel.

Conveyor Idlers. Fairfield Engineering Co., Marion, Ohio, announces an addition to its line of idlers for belt conveying systems. It is a Timken roller bearing idler of 6 in. diameter. The idlers are available in both the troughing and return roller types. They are built for belt widths ranging from 14 in. to 60 in.

Conveyor Belt. A conveyor belt constructed with an interlaced, cord-duck carcass, bonded through with a special rubber compound, has been announced by the Manhattan Rubber Manufacturing Division of Raybestos-Manhattan, Inc., Passaic, N. J. The manufacturer claims that the new belt possesses a high degree of flexibility and will not stretch or puncture.

Straight Edge. A combined straight edge scraper for road finishing is announced by the L & M Manufacturing Co., 10300 Berea Road, Cleveland, Ohio. The tool is designated as "Giant Gript." The handle and blades are of steel tubing, each 10 ft. long. A drop-forged steel connector between the two parts is an integral part of the handle. The tool is designed to be used for scraping the excess water and laitance off the slab at the time the surface is checked.

New Publications

Lathes. The South Bend Lathe Works, South Bend, Ind., has just issued a new General Catalog, No. 93. This 72-page publication illustrates, describes and prices the entire line of South Bend lathes in sizes from 8-in. swing to 24-in. swing. Also included are illustrations and descriptions of the attachment with which a screw cutting lathe can be fitted.

Rubber. The Diamond Rubber Co., Inc., Akron, Ohio, has just issued its new "Buyer's Guide to Mechanical Rubber Goods," designed to provide information on rubber goods for industrial uses in convenient form. It contains 24 pages of illustrations and data on many of the most widely used mechanical rubber products. It also lists standard stock sizes and list prices.

Deepwell Pumps. The Byron Jackson Co., Berkeley, Calif., has just published its bulletin No. 336 entitled "Deepwell Turbine Pumps." This booklet consists of 32 pages and illustrates and describes the characteristics of the company's deepwell pumps in different kinds of service. It also contains five pages of diagrams and descriptions relating to automatic pneumatic water systems.